DEVELOPMENT OF PROFESSIONAL NOTICING SKILLS
IN PRESERVICE TEACHER RESIDENTS: A CROSS CASE ANALYSIS

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ABSTRACT

Student achievement is rooted in a teacher’s ability to identify and assess student understanding of material. This is particularly challenging in classroom settings, which are dynamic and full of distractions, especially in science classrooms where discussion and inquiry are paramount. In mathematics education, the concept of professional noticing of children’s thinking refers to a teacher attending to, interpreting, and responding to student content understanding throughout a class period (Jacobs, Lamb, & Philipp, 2010). This skill is equally important when teaching other content, such as science, and is a key component of responsive and reflective practice used by excellent educators as outlined by reform standards for science (National Research Council [NRC], 1996, 2012; NGSS Lead States, 2013). Before a teacher can adapt to student needs, they must first identify critical moments of student sense-making and interpret the student’s ideas. Only then can they respond effectively. This set of teaching skills can be learned, and then later improved upon with practice and reflection. Recent research suggests that preservice science teachers can learn the fundamentals of noticing skills during specialized courses (Barnhart & van Es, 2015) and are able to carry forward this learning into their teaching experiences as full-time teachers (Amador, Carter, Hudson, & Galindo, 2017). However, little is known about the role of different aspects of preservice teacher education program experiences in laying the foundation for life-long development of noticing skills.
This study used a multiple case study design to explore the experiences of six preservice science teachers, as related to professional teacher noticing of student thinking about science, during the semester before their full-time student teaching experience. Based on a situated learning framework (Lave & Wenger, 1991), this study centered on the university- and field-based experiences associated with a middle and secondary teacher education program at a large, Mid-Atlantic, urban university. Participants were enrolled in a teacher residency program. Observations, semistructured interviews, and artifact analysis were used to identify opportunities for and experiences with learning professional teacher noticing of student thinking about science content throughout the first semester of this residency program.

Analysis of data included the use of a combination of a priori codes about the degree of teacher noticing of student thinking about science (Barnhart & van Es, 2015) and emergent codes of contextual events relating to opportunities for preservice science teachers to notice student thinking during field experiences. Case studies were developed, and a cross-case analysis performed to identify themes and trends in the learning experiences and development of the participants around noticing practices. Broadly, I found that the most access residents have to noticing is in their field experiences, and that their opportunities to learn to notice may be primarily mediated by their mentors’ abilities to “unpack” their own practice, communicate effectively with the resident, and help residents hone in on the content goals of lessons.
This study provides a unique examination of preservice science teacher learning opportunities at the interface of education coursework and field experiences. Assertions developed from this multiple case study analysis provide insight into which experiences have the most impact on the development of preservice teachers’ attention to student thinking.
This dissertation is dedicated to
my mother, Gay Gann (b. 1947-d. 2005).

She wanted me to be a doctor,
not a teacher. Now I can be both.
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CHAPTER 1

INTRODUCTION

The Research Problem

Our nation is undergoing multiple shifts in demographics and economic trends, and our schools need to be equipped to handle these changes. Aside from the need to develop and retain strong teachers who appreciate and understand the diverse backgrounds of our students (U.S. Department of Education, 2016), we need to consider the future skills and knowledge our students will need to be successful in life during the 21st century (Darling-Hammond, 2006). Rapidly advancing technology and scientific knowledge have opened the door to new careers and a future we can only imagine. In addition to unknown career opportunities, our society is increasingly engaging with scientific issues that permeate every aspect of modern life (National Research Council [NRC], 2012). Our schools need to respond accordingly. This means we need to carefully consider how we prepare teachers to help students meet this uncertain future.

Improving student outcomes, especially in light of recent calls to action for improving science, technology, engineering, and mathematics education, requires the finesse of expert teachers. The types of expertise required by teachers are manifold; however, the ability to differentiate between what is important and what is not may be a key skill that lays the foundation for effective teaching. In particular, the ability to hone in on student thinking about content, coupled with attending to students’ use of higher-
order thinking processes, is fundamental to creating rigorous and equitable classroom experiences for students (Haberman, 2006).

Unfortunately, novice teachers’ attention tends to be on student behavior and superficial learning (Sabers, Cushing, & Berliner, 1991; Star & Strickland, 2008). In my experience working with preservice teachers, I have noticed a tendency for preservice teachers to focus more on student behaviors—as though they are the key to unlocking student potential—and less on students’ understanding of content. Supporting this observation, there are various studies on student views of science (Logan & Skamp, 2008) and the importance of affect in science education (Baird, Gunstone, Penna, Fensham, & White, 1990; Demetriou, Wilson, & Winterbottom, 2009), but few on the impact of this superficial pedagogical choice on learning. As a result, there are countless resources about classroom management, but what is often missing is an in-depth discussion of the relationship between management and students’ cognitive engagement in the classroom.

One way teachers try to control behaviors in the classroom is to design activities that increase enjoyment. This makes sense to some degree because emotions and cognition are tightly intertwined (Pekrun, 1992, 2006), but the way this connection is interpreted in the classroom is less than ideal. As Pekrun (2006) explains, a variety of instructional considerations, ranging from quality of instruction to feedback, can impact student emotions and learning, meaning you can influence student achievement by shaping emotions in relation to the topic at hand. Additionally, emotions are involved in
the development of autonomy and values, which, in turn, can directly impact learning (Eccles & Wigfield, 2002; Wigfield & Eccles, 2000). Teachers should focus their attention on student learning in such a way as to capitalize on activating relevant emotions that are associated with increasing motivation. However, science teachers often interpret this need to capitalize on emotions as justification for prioritizing fun activities over those that hinge upon cognitive engagement (National Research Council, 2007). Making instructional choices based on this assumption does not directly lead to increased knowledge, and only can lead to long term learning over a long period of time after much sustained interest is developed (Hidi & Renninger, 2006).

Emotional engagement in science is important, but the focus needs to be brought back to the relationship between emotions and learning of content (Osborne, Simon, & Collins, 2003). This connects to the issue of classroom management, too, because engaging students in fun activities with low cognitive demand is an easy solution for controlling student behavior. With appropriate preparation, science teachers can learn to use strong teaching techniques that focus on student learning and content understanding, such as inquiry, argumentation (explanation building), and model building (Windschitl, Thompson, Braaten, & Stroupe, 2012) that can help bridge the gap between management and learning.

Teacher education programs are responsible for introducing teachers to these theoretical underpinnings, while also teaching novice teachers how to elicit and respond to student thinking effectively and appropriately. Contemporary teacher education
programs seek to balance exposure to theory and experience (Darling-Hammond, 2010). Additionally, of particular interest are accelerated programs that draw professionals from other careers into teaching, such as teaching residencies (Guha, Hyler, & Darling-Hammond, 2016). These programs emphasize fieldwork through extended school-based experiences, and integrate theory-driven coursework to varying degrees. It is important to note, however, that although there is evidence to suggest extended field experiences are valuable, research also suggests that these experiences need to be carefully designed and monitored in ways that assist in the integration of educational theory and practical knowledge (Dorel, Kearney, & Garza, 2016; Goodwin, Roegman, & Reagan, 2016; Zeichner, 2010). Therefore, it is important to conduct research that encompasses both traditional education programs and residencies.

In order for teacher education programs to continue to streamline their coursework requirements and focus their attention on the marriage between theory and practice, we need to identify programmatic elements that are associated with effective teacher preparation. For example, studies that explore whether programs effectively prepare novice teachers to attend to and interpret student thinking, or are simply reinforcing the natural tendency of educators to pay attention to process skills and behaviors (Talanquer, Bolger, & Tomanek, 2015), would be a valuable contribution. Process skills are valuable to learn, given the importance of scientific processes for the development of scientific thinking. However, focusing only on what scientists do is not as important as understanding why these processes are used and how they influence our
understanding of natural phenomenon. Similarly, addressing behaviors is also important, but they are not of primary importance for learning, despite the asymmetrical amount of concern preservice teachers have for classroom management (Meister & Melnick, 2003).

To this end, there is evidence that the development of a student teacher’s abilities to attend to student ideas and adjust lessons accordingly (i.e., professional noticing skills) can be aided through careful scaffolding, such as with the use of video interventions (Barnhart & van Es, 2015). However, we do not yet know what role university-based courses and pre-student teaching experiences hold in laying the foundation for development of science teacher noticing practices. This study sought to fill this gap of understanding by examining the opportunities preservice teachers have to engage with noticing practices throughout the semester leading up to their student teaching.

Purpose

The purpose of this study was to examine exposure to and development of a single pedagogical skill, professional teacher noticing of student thinking, in real-time. Briefly, professional teacher noticing is a set of skills (i.e., attending to, interpreting, and responding to student thinking) focused on the interface between teachers and students during classroom-based interactions that support development of student understanding of content (Jacobs et al., 2010). This skill set was selected as important because in practice it bridges the divide between student and teacher. A teacher cannot read students’ minds, yet needs to identify what a student understands about material in order
to be able to intercede if the student has misconceptions or facilitate further if the student needs to deepen their understanding.

Learning the basics of this skill set early on sets the stage for novice teachers to grow into strong educators. When teachers systematically focus attention on student learning and thinking, they are simultaneously engaging students in the practice of being critical thinkers (Darling-Hammond, 2010) while also assessing effectiveness of their lesson and, ideally, adjusting their lessons in as close to real-time as possible (Jacobs et al., 2010). Research shows there is a relationship between how teachers engage students and student achievement (Nystrand & Gamoran, 1991). More broadly, focusing on cognition rather than behaviors potentially increases opportunities for more students’ equitable access to learning in the classroom (Haberman, 2006). By focusing in on the ability to notice student thinking, we can examine how effectively teachers—in the case of this study, novice teachers—are engaging students in the learning practice. The scope of this study is limited to describing the contexts and cues associated with novice teacher engagement in noticing, but this can open the door to a deeper examination of effective noticing practice and how it can be leveraged to improve teacher-student communication and, ultimately, equitable access for all students in science classrooms.

Significance

Currently, we know little about how different aspects of preservice teacher education experiences contribute to the development of responsive and reflective educators (Jay & Johnson, 2002). Given the push to generate more programs that are
practice-based (Guha, Hyler, & Darling-Hammond, 2017; Hammerness, Williamson, & Kosnick, 2016), it is important to understand what aspects of traditional teacher education programs are most useful in the production of effective teachers and how to adapt these tools to instructional environments that rely heavily on apprenticeships within classrooms in the field (Zeichner, 2010).

This research study is significant because it provides insight into the specific experiences in which preservice teachers in residency-based middle grades and secondary science education programs engage, and how these experiences may influence their ability to focus on and respond to student thinking. The ability for science teachers to identify and respond to student thinking is a key component of reform science educational practices (NRC, 2012).

Research Questions

This project is the result of my ongoing interest in understanding how math and science content knowledge “experts” with limited teaching experience develop the ability to notice (i.e., prioritize paying attention to and then adapting instruction) student thinking about science content and practices. Through my work with a specific teacher residency program, I gained access to program-wide participants ranging from new residents to teaching staff to those who work behind the scenes. This dissertation represents a deep dive into the interplay of the variety of contexts and influences that define this particular residency experience. Therefore, I took this opportunity to explore how residency program-based experiences of preservice teachers influence the
development of professional teacher noticing skills in science classroom settings. My research questions are as follows:

1. What professional noticing practices do preservice science teachers (PSTs) learn about, observe, and engage in when interacting with student ideas and work in science?
2. How do PSTs’ engagement with noticing practices develop over the course of the semester?
3. Given access to similar university-based experiences, how does domain of specialization (math versus science) relate to PSTs attending to student thinking?

Definitions of Terms

Below is a list of key terms and their operational definitions used throughout this dissertation.

- **Formative assessment and evaluation**: For the purposes of this dissertation, the use of the terms “formative assessment” and “evaluation” will mainly refer to the activities used by science teachers to elicit student ideas, unless otherwise noted (i.e., in reference to program evaluation or teacher evaluation). Formative assessments may be formal or informal. In the context of teacher noticing, formative assessment is always informal in the sense that it occurs mid-discussion and may not be planned ahead of time; however, there are examples where pre-planning questions has been useful to teachers (Amador et al., 2017).
• **Knowledge vs Understanding:** Throughout this dissertation, I refer to knowledge and understanding as two distinct terms. Knowledge references a collection of facts or concepts with no indication of connecting mechanisms or conceptual explanations. Understanding refers to a knowledge of a deeper connection between concepts that includes some level of conceptual explanation or meaning beyond an identification of ideas. The challenge with these terms is that although I use them in this way, not all of my participants did and they would often explain that students “understand” when they can use the same algorithm to do a set of problems rather than transfer to an entirely new situation. In these cases, I took their use of “understand” to be simply the equivalent of “know.”

• **Mentor:** Although there are many people involved in mentoring the primary participants of this study, the term mentor (noun) is reserved exclusively for the cooperating teacher with whom the residents are matched for the duration of the program. Mentors welcome these preservice teachers into their classrooms, share teaching duties with them, and share their expertise through modeling and feedback.

• **Middle grades education:** This study uses the definitions of middle grades education currently used by the state in which this research was performed. Middle grades education covers 4th through 8th grades, where 4th through 6th grade teachers often teach all subject areas and teachers of grades 7 and 8 are assigned to a specific content area (mathematics, science, language arts, social studies, or electives).
• **Practicum**: Due to the fact that teacher residents engage in varying degrees of co-teaching from the beginning of the academic year, throughout this dissertation the term practicum is used to describe the period of time in which the residents are teaching in their school site prior to the official start of student teaching. In the case of this residency program, there are two practicum sites for each resident teacher: the school of residence and the school in which they participate in field-based experiences for their methods classes. These sites are described in more detail in Chapter 3, “Settings.”

• **Preservice teacher (PST)**: This term refers to any novice teacher who is engaged in a teacher education program but is not yet certified. For this study, PSTs are all graduate students enrolled in a residency-based teacher education program at a large university.

• **Professional teacher noticing of children’s thinking** (or simply noticing): Jacobs et al. (2010) define professional teacher noticing as a specialized form of noticing that involves the active engagement of teachers within an instructional situation to:

  - **Attend to** – To identify student strategies and ideas
  - **Interpret** – To make sense of the student(s)’s ideas
  - **Respond to** – To make a pedagogical choice that will address (or not) the student(s)’s ideas, as based on the teacher’s interpretation of them

• **Residency and Residency-based**: Teacher residencies are teacher education programs wherein preservice teachers balance university coursework and frequent field-based
experience, which includes co-teaching and observing a class four days a week. The residency at the center of this study is described in more detail in Chapter 3.

- **Responsive teaching**: An umbrella term used by science educators that includes professional teacher noticing (Robertson, Atkins, Levin, & Richards, 2016), wherein the focus is on the teacher’s role to identify and build upon student ideas. In my experience, science education researchers refer to “responsiveness” more frequently than noticing, perhaps because it focuses the attention on how the teacher actively reacts to student thinking. Responsiveness is a key component of ambitious science teaching practices (discussed in Chapter 2) and other reform movements (NRC, 2012; Windschitl, Thompson, & Braaten, 2018).

- **Science domains**: Science as a field is made up of multiple sub-fields that are often intertwined and interrelated, particularly at the K-8 level. This dissertation refers to each sub-field or collection of sub-fields as a domain. For example, middle grades science teachers often teach within the collective domains of life science (domain: biology), physical science (domains: chemistry and physics), and earth/space science (domains: geology and astronomy).

- **Secondary education**: In the state where this study was conducted, secondary certification is limited to those grades 7 through 12, where teachers specialize in a specific content area (for science in this state, this includes: agriculture, biology, chemistry, Earth and space science, environmental education, general science, and physics).
• **Teaching domain:** Teachers engage in a variety of practices inside and outside the classroom setting. Each subset of skills will be referred to as a teaching domain. For example, classroom management, building relationships with students, familiarity with content, familiarity with pedagogical moves, etc., can all be considered teaching domains. A teacher’s ability to reference and use a combination of all teaching domains can be seen as their pedagogical content knowledge (PCK) (Shulman, 1986), which will be defined in greater detail in Chapter 2.

• **University-based:** This phrase refers to any course, discussion, or assignment that is directly connected to the home university of the residency program. Specific contexts and artifacts related to the university are described in more detail in Chapter 3.

**My Positionality**

The research and analysis contained within this dissertation are directly connected to my experiences and perspectives as a scientist, educator, and mentor. It is my belief that no one enters a situation truly open and free of bias. To this end, I wish to take a moment to identify some of my biases and explain what drives my analysis.

First, as an experienced scientist, I am always looking for evidence and have been working hard to broaden my interpretation of what should be included as evidence. Some things cannot be measured easily, but can be used to provide insight into contexts and rationale. In terms of this study, I have tried to set aside my temptation to count events and assign weights because I am aware of the fact that I only managed to get a snapshot of what was happening during the semester I collected data. There is, I am sure,
a lot I did not witness, but instead have to infer from select observations, reflective writing, and other people’s feedback.

Second, as a teacher, I have always leaned toward focusing on content understanding over accuracy. I was the teacher who confounded students by refusing to allow them to say they “proved” anything and that they could argue almost anything if they had the evidence to back themselves up. I have a very deep conviction borne out of experience that learning is to be supported by classroom management, not the other way around. It has always pained me to walk into a classroom where learning is cast aside in order to spend time on reinforcing behaviors and idealized, teacher-centered classroom organization. I also, as a teacher-scientist, have always relied upon open ended questions and dialogue to propel learning forward in my classroom. This drives this study because I wanted to see how this idea plays out in other classrooms and whether or not the residency model provides opportunities to explore the relationship between learning and pedagogical choice more deeply than is perhaps afforded by a “typical” student teaching experience.

Finally, as a mentor, I have often told my student teachers to “choose their battles.” By this, I mean, to determine what is important in terms of learning and then what needs to be done by them to support this learning. If that means keeping a box of golf pencils by the door in order to help students transition to doing work more quickly, then so be it. Despite the efforts of administrations for which I have worked, it has never been worth my time to mandate how students position their bodies because I know
adolescents and I know how they learn. I have been successful as an educator perhaps because of the controlled chaos that is my classroom. Students are allowed to stand and sit in alternative ways, as long as they are learning and not distracting others. Explorations are lively and energetic and involve my blending into the classroom, so much so that guests often have a hard time finding me amongst my students. I realize this method is not ideal for all teachers, but I do think at the heart of it is a truth that I feel is worth pursuing and clarifying.

To this end, all of my observations made and inferences drawn are colored by what I believe to be ideal, student-centered instruction. I do not judge those who do not meet my ideal, instead I am curious as to their reasoning and am open to being convinced of other paths. This study has provided me an opportunity to explore the limits of my own beliefs, while also pressing others to think about theirs. I intend to keep pushing my limits and challenging myself and others to examine what makes good teaching good.

Organization of Dissertation

This dissertation begins with this chapter as a broad overview of my study (Chapter 1), and then continues with a review of literature pertinent to the examination of teacher noticing in science classrooms (Chapter 2). Next, I situate this framework within the broader context of teacher education and follow a unique research program to examine teacher noticing in science classrooms during preservice teaching experiences. Then, in Chapter 3, I explain how I performed this study, including the research population, data collection, and analysis. Chapter 4 provides an introduction to the case
studies in the quintain and a response to Research Question 1, including the major themes identified in my analysis of my participants engagement with noticing and noticing-related practices throughout the study. Chapter 5 responds to Research Questions 2 and 3, starting with a series of case studies exploring resident engagement with noticing practices throughout the study. Chapter 5 concludes with a cross case analysis comparing the experiences and outcomes for all of the cases. Finally, this dissertation ends with a chapter describing lessons learned from this study, an analysis of the study’s strengths and weaknesses as pertains to the assertions made, and suggestions for future study.
Science teaching is incredibly complex and complicated. Complex because there are many different skills and knowledge bases that teachers need to have in order to be effective. Complicated because, contrary to popular belief, it is neither easy to learn nor practice being a good science teacher. Science teachers teach in multiple contexts (e.g., laboratory settings, traditional classroom settings, etc.), teach about multiple domains (e.g., biology and chemistry overlap in content, although each has its own unique attributes), and balance multiple expectations (e.g., assessment-based, culture-based, etc.). A science teacher needs to have flexible knowledge of their content, but also contend with reforms and expectations (NRC, 1996, 2012; NGSS Lead States, 2013). Additionally, some middle grades teachers, depending upon teaching site, may not focus on a particular domain, but instead teach units related to multiple domains (e.g., grade 7 science teacher may teach three different units in a year, each focused on a different domain: biology, earth science, and physics). Therefore, teaching middle grades requires a broader content knowledge base and even more flexible thinking about instruction. For these reasons, it is important to provide prospective science teachers strong, evidence-based preparation during their teacher education programs.

In this chapter, I make an argument for studying how preservice teachers are introduced to and are exposed to opportunities for practice using a set of teaching skills (professional teacher noticing) and what the implications are for the future of science
teacher education. First, I define the relevant knowledge domains of science teachers, then I introduce a framework for exploring science teacher pedagogy around engaging student thinking and explain how this framework can be applied to different aspects of science teaching. Next, I place this research within a theoretical framework to explain how teachers learn to be teachers. Finally, I describe my research and the implications it has on science teacher education.

Teaching Science

This study examines the learning trajectories followed by novice teachers during an almost full-time apprenticeship, wherein they learn the foundational skills they will rely upon during student teaching and beyond. In particular, I examined how these six novice teachers engaged in noticing practices, which are foundational skills for becoming the type of teachers the world of science education reform has called for (NRC, 2012).

In this section, I describe the domains teachers engage with, particularly science teachers, when running a classroom and selecting curricula, then I will describe some different teaching practices that are used by science teachers today. Teaching is, as mentioned above, complex. Therefore, it is important to delineate and acknowledge the various demands on teachers in the classroom and how these require teachers to develop a transformative teaching skill that incorporates a variety of types of teacher knowledge. The next two sections will describe teaching domains broadly and then describe the role of Next Generation Science Standards (NRC, 2012; NGSS Lead States, 2013) in teaching science. Then I will describe different aspects of pedagogy related to the broader theme
of this dissertation around exploring the interface between student and teacher conceptions of content.

*Teaching Domains and Pedagogical Content Knowledge*

In order to understand what is involved in learning to teach science, we must first address some of what is involved in teaching. Teaching well requires a mastery of many different skills. Effective teachers must not only understand the content they are teaching, but also have a clear understanding of their students' thinking and background experiences, a repertoire of teaching tools (pedagogy), and managerial skills, to name a few.

In the late 1980s, Lee Shulman reflected on his experiences observing teachers and devised a model for thinking about the “special amalgam” of skills teachers attain, which he called “pedagogical content knowledge” (Shulman, 1986, p. 9). His early model included seven categories of teacher knowledge: content knowledge, general pedagogical knowledge, curriculum knowledge, knowledge of learners and their characteristics, knowledge of educational contexts, and knowledge of educational ends. Each category, or teaching domain, contributed in some way to a synergistic outcome (i.e., the seventh category) referred to as PCK. [Note that although Shulman spends a great deal of time defining different forms of knowledge, he did not differentiate “knowledge” and “understanding” in the same way I do in Chapter 1. However, I have interpreted some of his uses of “knowledge” to include my use of “understanding,” especially pertaining to situations where teachers apply their knowledge to their classrooms; Shulman, 1986.]
For this study, pedagogical content knowledge (PCK) is, as defined by Magnusson, Krajcik, and Borko (1999), the result of the transformation of content knowledge, pedagogical knowledge (including assessment, curricula, and instructional strategies), and knowledge of students’ understanding. Each component of PCK is, on its own, challenging to identify and measure, and the resulting entity referred to as PCK remains elusive at best. Many researchers default to either measuring each separate component, thus undercutting what may be the true nature of PCK (e.g., Zembal-Saul, Starr, & Krajcik, 2002) or they use one of a variety of different measures that may map more directly to PCK but, as yet, lack consensus support from the broader research community as being truly good measures of it (e.g., Nilsson & Loughran, 2012). Because PCK is complex and difficult to measure empirically, it is important to continue to try to identify specific, measurable aspects of skills that are unique to teachers, but also give insight into the inner workings of highly effective teachers. One important area that is included within the cloud of PCK but is worth examining in detail is the interface between student thinking and teacher perceptions of student thinking.

*PCK in Science*

Pedagogical content knowledge (PCK) is a highly researched, but oft debated, topic in science education. For the purposes of this dissertation, I will focus on PCK as a defining characteristic of strong science teachers who use a variety of informational sources and reflective practice to create highly specific and responsive classroom practices that result in increased student achievement.
If effective teaching involves creating an environment and situation wherein students can learn, then effective science teaching, as per the *Next Generation Science Standards* (discussed further below), includes tying together content knowledge and practices in a classroom environment where all students can access the content equitably (NRC, 2012; NGSS Lead States, 2013). Aside from content knowledge that includes an understanding of both concepts and the processes by which science works (again discussed below in reference to NGSS), science teachers must also know how to engage in these practices and tie them into the fabric of their classroom. Ideally, this results in teachers creating a learning community that uses science practices (such as using evidence to support reasoning and looking at patterns in data) as they learn. Given the framework for PCK described by Magnusson, Krajcik, and Borko (1999), this means teachers must integrate how to teach science, what to teach in science, how students learn science, what students struggle with in science, and how to assess science content and process understanding. The NGSS and a general move toward integrating inquiry practices more fully into science courses also push for a deeper look at student understanding and assessment of content knowledge by adding in a dimension of culturally responsive pedagogy, which acknowledges the role of culture in learning and acknowledges the diverse backgrounds and experiences of modern students (Lee, Miller, & Januszyk, 2014; NRC, 2012). Therefore, it is important to include an understanding of culture in our discussion of what it takes to be a good teacher, as it influences student
understanding and interpretations of content that then have an impact on decision making about how best to assess this understanding.

As a science education researcher, I want to acknowledge the complexity of what it means to teach, while also looking at ways to understand and improve upon how to best use a model like PCK in my practice and research. For example, even though the idea of PCK is difficult to measure, we can still incorporate pieces of it in our work as a way to track and influence teacher development. Hanuscin, Lee, and Akerson (2011) used the transformative model of PCK to explore and describe how elementary teachers teach the nature of science (NOS). The authors show that there are dynamic interactions between each component of PCK, and therefore as one aspect of PCK is increased, there are effects on other aspects, plus on the overall PCK of the teacher being observed. In terms of teacher education, a difficult challenge of this model is that it is difficult to assist preservice teachers through the process of identifying and increasing PCK. It is much easier to focus on the component parts, which is why, despite the attractiveness of the dynamic nature of the transformative model, most researchers still break down PCK into component parts during analysis (e.g. Nilsson, 2008). But I think either way, one can still use this information to inform our practice as science teacher educators. In the case of this dissertation, I wanted to look at how the varied contexts and factors preservice teachers encounter as they traverse their teacher education program impacts their assessment of student thinking. Those factors represent different pathways toward learning the pieces that make up PCK. From learning about assessment in methods
courses to learning how to question students from mentors to discussing burning issues around student culture and development with peers, these all potentially impact what the preservice teacher learns to do.

**Content: Next Generation Science Standards (NGSS)**

Development of the NGSS (NGSS Lead States, 2013), based upon *A Framework for K-12 Science Education* (NRC, 2012), combined contemporary knowledge about how students learn science with what science needs learning and when. This last point of what and when is complicated by the fact that what is “science” is incredibly broad; however, recommendations were made to focus on those topics the committee saw as being foundational, expansive (room for growth and increasingly sophisticated examination over time), and interdisciplinary. The new standards were designed to bring attention to how science works and away from what science produces. Additionally, the NGSS team incorporated current knowledge of how people learn and kept in mind the goal of making science accessible for everyone (Lee et al., 2014).

**Disciplinary Core Ideas**

First, there are the “disciplinary core ideas,” where the NGSS outlines learning progressions within each of four domains (physical, life, and earth/space sciences, plus engineering). These are reminiscent of the traditional informational pieces of content that many associate with science but distilled down to what NGSS team considered essential. Standards in this section include statements such as, “different properties are suited to different purposes” in reference to the structure and properties of matter.
Crosscutting Concepts

Second, there are the interdisciplinary themes or “crosscutting concepts” that are interwoven between all scientific endeavors, such as the flow of energy (for example, this would include a discussion of conservation of energy in a variety of different contexts ranging from metabolism to rocket launches). These concepts build connections between scientific domains, making it clearer that science is a unified subject and not merely a series of disconnected subjects. In my experience as a biologist, I used chemistry, physics, mathematics, engineering and more to do biology. These domains informed each other and were not completely separate, unlike how science has traditionally been taught in American schools.

Science and Engineering Practices

Finally, there are the practices, which outline scientific skills and processes, that get at the epistemic nature of science. For example, scientists regularly use evidence to support claims they make or use different types of models to explore natural systems. These practices are specifically designed to highlight how science is done, but also double as a way to frame talking about inquiry in a broader sense, because these skills are often used in multiple contexts outside of science.

Science for All

In addition to the shift toward teaching science through inquiry, the Framework and NGSS unify science education so as to provide students with a holistic and sophisticated understanding of how science works (Osborne, 2014). In this new world of
science teaching and learning, science is taught through inquiry practices that are also accessible to all students. I discuss inquiry further in the next section, and the related concept of responsive teaching in the section, “Pedagogy in Practice.”

Inquiry

Since around the mid-twentieth century, science educators and policy makers have been concerned with making certain that American students not only understand scientific content, but also the scientific process (this history is nicely summarized by Duschl & Grandy, 2013). Current science standard recommendations acknowledge that doing science involves a process of knowledge construction made up of several inquiry-centric skills such as asking scientific questions, using computational thinking, and constructing explanations (i.e., the practices listed in the Framework; NRC, 2012). The term inquiry here refers to the processes involved in making sense of the material world/universe in such a way as to generate predictive explanations based on evidence. However, the term inquiry also describes a pedagogical method used within the science classroom.

Inquiry in the classroom refers to the process of engaging in the scientific practices to learn content. In this way, inquiry refers to a form of instruction that encourages students to learn through exploration, but also demands a certain amount of metacognitive reflection by students (Crawford, 2000; NRC, 2005). However, inquiry also describes the process used by scientists to engage in scientific research, the understanding of which is a major goal of contemporary reform movement (NRC, 2012).
In this sense, inquiry is learned through inquiry, much like an apprentice learns from experts (Lave & Wenger, 1991). One of the biggest challenges associated with inquiry-based science instruction, however, is that often science teachers have little to no experience with authentic scientific inquiry as they likely learned through direct instruction and minimal, highly-guided activities (Windschitl, 2003). This is particularly of consequence in science because teachers with limited appreciation for the nature of science may default to teaching science more as a collection of facts than a series of interconnected concepts that together explain how the universe works (Fang, 1996; Mansour, 2009).

Assuming teachers and students need to engage in inquiry-based practice in order to fully appreciate and understand the various components of science (NRC, 2012), then we need to also address how teachers meet this goal. In this case, the role of teacher noticing in inquiry instruction is subtle but important. For teachers to effectively monitor and guide students in using scientific practices, especially those that require communicating their ideas to others (one of the scientific practices mentioned above), teachers need to be paying attention to and responding to student thinking. This means they need to identify when students are engaging in a practice, identify whether the student is using it correctly, and then make an adjustment accordingly. And while they are doing this, they must also be attending to the student’s conceptual understanding of whatever content they are engaging with through the inquiry process. This requires a great deal of expert understanding and flexible thinking on the part of the teacher. All of
these skills can be seen in novice teachers who have received instruction about paying attention to student thinking, but it is very challenging to become an expert in these skills (Talanquer, Tomanek, & Novodvorsky, 2013), leaving room for improvement in teacher education programs specifically targeting future science teachers. However, there is, as yet, little research into the ways science teachers, especially at the middle grades level, perform this ongoing evaluation of ideas (i.e., formative assessment) nor how they make decisions about how to respond accordingly.

**Discourse**

Communication is of primary concern in science; knowledge is not valued unless it has been communicated to and evaluated by the scientific community. Science, despite the lay perspective of the lone scientist, is a communal activity. Therefore, it is unsurprising that a great deal of research in science education has focused around various aspects of discourse—teacher-student and student-student, written and oral (for a review of discourse in science education, see Kelly, 2007). Professional teacher noticing can be seen as a piece of the discourse puzzle.

Teacher noticing has the potential to bring together two different, yet significant, arms of science education research—research into use of argumentation and research into student misconceptions. In a way, these two areas are indicative of the epistemic views of science. One camp argues that the most important aspect of science one has to understand is knowledge construction in science (e.g., nature of science) and the other camp sees content understanding as being primary (e.g., dealing with student misconceptions). In
recent years, there has been heavy focus on argumentation as primary for understanding science. Argumentation is an inquiry practice, but also an important part of discourse, where one constructs and argument based on evidence in order to persuade or explain. For example, (Duschl & Obsborne, 2002) argue, “teaching science needs to accomplish much more than simply detailing ‘what we know’” and becoming familiar with the “techniques of the domain,” while also teaching students “science as a way of knowing” (p. 40). This places argumentation and scientific explanation as primary to all else, but leaves open the question as to whether this is enough or even where we need to begin when preparing new teachers. Since teachers are not necessarily well versed in true inquiry (Windschitl, 2003), there is room to improve on this front; however, it is also important to not lose sight of the conceptual underpinnings of scientific thought.

One way researchers have examined the interface of discourse and student thinking is through research into teacher questioning. Research into constructivist conceptual change models (Duit & Treagust, 2003) of student learning has helped shift the use of teacher questioning away from being purely evaluative (are students right or wrong) to having a dual purpose of eliciting student thinking as well as engaging students in co-construction of scientific knowledge (Smith, Blakeslee, & Anderson, 1993). For example, Chin (2006) observed that science teachers engaging students in higher order thinking processes use a variety of forms of questioning throughout this co-construction of knowledge purposefully in such a way as to guide students as if climbing up what she calls the “rungs of a ‘cognitive ladder’” (p. 837). This is in direct contrast to the lower
order initiation-response-evaluation (IRE) questioning systems traditionally used by teachers. This type of research into classroom discourse patterns connects directly to professional noticing for example, Smart and Marshall (2013) show that teacher questioning and student cognitive engagement are linked. Professional teacher noticing is a core set of skills teachers use when engaging students in classroom discussions—teachers who are better able to ask good questions are better able to elicit student responses that demonstrate their thought processes, which means teachers can then interpret these responses and make decisions about what questions or activities need to follow. For example, in the case of a classroom discussion, the teacher may realize one student has a weak understanding of something another student has a strong understanding of, and will then encourage the second student to explain their conception to the first, thus effectively providing an opportunity for re-teaching through classroom discourse.

Science practices intertwine with science content, but understanding and improving teaching practices, including focusing on student-centered argumentation, requires a baseline ability of teachers to enact noticing practices. Essentially, students cannot effectively use evidence to support claims unless they understand the content they are referencing. Expert teachers are able to assess, evaluate, and respond to student understanding while students are engaging with the material. This leads to the question as to whether the ability to notice is purely developmental or rather a skill that, once introduced, evolves with practice. If teacher noticing is a foundational skill learned
through experience and exposure, rather than discovered as part of a developmental process, novice science teachers need to learn about noticing before they enter a classroom and then engage in deliberate practice of noticing in and out of the classroom.

Teacher Development

As a teacher moves from preservice to induction and beyond, their knowledge and skills change. These changes teachers undergo cover a wide variety of dimensions, represented by the different types of knowledge required to develop pedagogical content knowledge. For the purpose of this dissertation, I focused on the interface between content knowledge and knowing students within two contexts for preservice/novice teacher development, their experiences in methods courses and the field. To that end, I will discuss teacher knowledge, teacher beliefs, and teacher education programs.

Teacher quality has direct implications for student achievement and is heavily influenced by teacher experiences in preparatory programs (Darling-Hammond, 2000; Guha et al., 2016). Therefore, it is important to examine the ways we frame science teaching to new teachers. The way teacher educators perceive teacher development is important for understanding how teacher education programs are framed and the academic values (and potential) of the teachers produced by these programs.

Teacher Knowledge

As mentioned above, PCK describes the transformation of various knowledge bases teachers use in their practice (Magnusson et al., 1999; Shulman, 1986, 1987). Teacher knowledge bases traditionally have been examined using developmental models
such as learning progressions. Learning progressions/developmental models describe, typically in a step-by-step fashion, the trajectory typically followed when learning about a topic or a new skill (see Duncan & Hmelo-Silver, 2009, for an example relating to the Next Generation Science Standards, which are in and of themselves learning progressions). Schneider and Plasman (2011) broke down PCK into its major component parts and examined the literature to see what research has shown so far to be the typical pathways to learning the different aspects of professional teacher skills. Their work highlighted learning progressions potentially useful for identifying what preservice teachers need to know and how to better help both preservice and inservice teachers using reflective practice to become better teachers. For example, in terms of how teachers perceive the nature of how students learn science, Schneider and Plasman’s progression suggests it is natural that teachers first believe students learn best through transmission, but with experience teachers learn that students learn best through exploration with teacher guidance. However, as Levin, Hammer, and Coffey (2009) point out, it is limiting to look at teachers from only a developmental perspective. And certainly, as research has shown, experience alone is not sufficient for helping teachers move along these progressions (Darling-Hammond, 2000).

Another interesting piece of evidence that suggests that introduction of foundational skills, such as noticing student thinking about content, should happen early in order to support later development of expertise is a recent study by Amador, Carter, Hudson, and Galindo (2017). This case study showed, just as Levin et al. (2009) and
Santagata and Yeh (2013) demonstrated, that laying a strong foundation during preservice teacher education experiences (in these cases, during methods courses), is associated with integration of these practices over time, including into induction (Amador et al., 2017).

Although it would be useful for policy makers and administrators to identify categories of teacher skills, it is not practical to use these as an evaluation device unless every teacher follows the same trajectory. Given the diverse backgrounds of preservice teachers, especially those in post-baccalaureate residency programs, it does not make sense to assume that everyone will be coming in with the same abilities or beliefs, nor will they necessarily follow the same pathways as they develop their teaching skills. However, given that early introduction of important skills is associated with integrating these skills later, these categories provide a framework for determining which skills are most useful to introduce.

*Teacher Beliefs*

Another important factor for understanding teacher education is the beliefs teachers hold about not only their own learning, but also the learning of their students. Again, in terms of the new standards, it is important that teachers hold the belief that teachers are more than disseminators of information, but rather are guides that help students create knowledge for themselves. As Hammer (2016) points out, “explaining is not effective for teaching concepts in science” (p. 250). However, whether or not teachers (new or otherwise) internalize student-centered practices that foreground student thinking
are used is ultimately up to whether or not the teacher believes in the utility of the practice (Haney, Czerniak, & Lumpe, 1996; Roehrig & Luft, 2004). Novice teachers’ beliefs about teaching and the nature of science come out of their own experiences, but can be influenced by their experiences in teacher education programs (Brownlee, Purdie, & Boulton-Lewis, 2001). Deep exploration of the nature of teacher beliefs is beyond the scope of this dissertation (see Bryan, 2012, for a review of this topic), however, it is important to acknowledge that the beliefs held by the participants can and do impact how they choose to structure their classes.

When examining the development of a teacher, it is important to acknowledge and identify these beliefs because of their impact on the uptake of reform ideas in the classroom, and this is no less the case when looking specifically at noticing practices (Schoenfeld, 2011). For example, a preservice teacher who holds simplistic beliefs about the role of a teacher as a transmitter of knowledge may be less likely to pay attention to the use of noticing skills by their mentors and peers, and therefore possibly less likely to use these skills in their own classrooms. Additionally, if they do not believe in student-centered teaching, they will not make the effort to practice noticing beyond that which makes it clear the student(s) know a specific answer or can do a particular procedure (Roehrig & Luft, 2004). One approach to studying teacher beliefs that is relevant for this study is Luft and Roehrig’s (2007) Teacher Belief Interview (TBI) protocol. The TBI was designed to illuminate the stance of the interviewee in terms of their ideas about teaching and learning through questions that ask them to reflect on what they do to help students
learn, but also what their personal explanations are for how students learn and how they see themselves as teachers.

By explicitly asking for preservice teachers’ and their mentor’s observations about their preservice teacher’s classroom activity, Luft and Roehrig have been able to show that teacher beliefs can and do change. Additionally, and most importantly for my study, engaging teachers in this interview process opened teachers up to discussing their deeply held ideas about what is true and provide insight into the “complexity of [their] belief system” (p. 49) in a way that and observation may not have been able to uncover. In other words, I could observe a novice teacher teach, but depending upon how they perform their co-teaching duties (e.g., observe their mentor and then teach a lesson versus plan and implement a lesson with minimal feedback from their mentor), I might not have seen a true representation of their ideal teaching practice and need to additionally discuss with them their views on teaching.

Luft and Roehrig (2007) created five categories to describe the different types of teaching beliefs (or orientations) they saw: Traditional, Instructive, Transitional, Responsive, or Reform-based science teachers. The first two categories of teachers’ definition of science are unsophisticated, where they believe science is a collection of facts or at most an objective process that leads to clear answers. Traditional teachers see themselves as providers of these facts, and their job is to impart knowledge. Instructive are those teachers whose orientation is still teacher-centered, but with a focus on pedagogical choices that maintain order or provide students with experiences and no
elaboration on how those contribute to student learning. These teachers may have a slightly more sophisticated view of science than Traditional science teachers, but it is still fairly unsophisticated. Transitional teachers are concerned with relationships between the teacher and the student(s), but also see science as a straightforward process, easily defined within the confines of the traditional “scientific method.” The last two types of science teachers (Responsive and Reform-based) tend to have more dynamic, and therefore realistic, views of science, wherein they understand that science is a social and cultural pursuit that is subject to revision. Responsive teachers reflect this belief about science in that they tend to incorporate peer-to-peer feedback or student reflection in their work, mimicking the way scientific knowledge is generated. Reform-based science teachers have an orientation that acknowledges the way students learn and uses scientific practices to facilitate this learning, where instruction is adapted to suit the knowledge and understanding of the students at any point in time.

Research on typical teacher development and beliefs can provide insights into assessing and responding to the strengths and weaknesses of preservice teachers entering teaching programs, providing a benchmark to consider as faculty prepare to work with preservice teachers. However, it is also important to understand when and how these beliefs are shaped during teacher preparation and how these beliefs relate to the learning and integration of pedagogical practices. Therefore, below I introduce the pedagogical practices that are important for implementing reform-based instruction aligned to the NGSS (NGSS Lead States, 2013). Then I will address how these skills are taught in
teacher education programs by describing how we currently use a cognitive apprenticeship to provide access to examples and opportunities for learning how to enact these practices.

Pedagogy in Practice

As discussed above, middle and high school teachers translate relatively expert content knowledge (at least as compared to their students’ content knowledge) into something manageable by students and then guide students as they learn this material. To do this effectively, teachers must have expertise in multiple domains: the content area, classroom management, and communication, to name a few. Each of these domains are in themselves manifold and intertwined. Teachers need at least enough expertise in their content to be able to identify meaningful learning goals, effective methods for teaching, and timing for when to apply said knowledge domains (i.e., PCK) (Magnusson et al., 1999; NRC, 2000). As supported by the reform movement, best teaching practices include adjusting one’s teaching to the specific needs of one’s students (National Council of Teachers of Mathematics [NCTM], 2000; NRC, 2012). Teachers, as a result, must be skilled at assessing student ideas, while also guiding and engaging them in the processes that scientists use to make sense of scientific evidence (inquiry; see above). In order to identify student needs, teachers must be able to identify and interpret student thinking about the topic at hand. Therefore, noticing skills (discussed further below), as a part of responsive teaching, are a foundational skill set that underlies the NGSS guidelines for effective science teaching. Because noticing involves directly engaging with student ideas
during classroom time and is typically rather informal, it falls into a realm of formative assessment tasks.

As an instructor, formative assessment has always been a big part of my student-centered teaching, where I use various tools or techniques to elicit student thinking and explanations around content. It is possible to define formative assessment broadly enough to encompass almost all activities undertaken by teachers that produce information the teacher can use to modify or evaluate their teaching (Black & Wiliam, 1998). A skilled teacher can and does use a wide range of pieces of evidence to support their instructional practice, as Black and Wiliam (1998) showed when they examined several examples from studies in K-16 classrooms. However, for the purposes of this dissertation, the main discourse involving formative assessment is around tools and practices teachers use to illuminate student thinking and guide the teacher’s instructional choices. Whether we are talking about the process skills described by discursive processes at the forefront of ambitious science teaching practices (responsive teaching, discussed next) or noticing (discussed after responsive teaching), the student’s understanding and thinking about a topic is the focal point on which the classroom’s trajectory should turn.

*Responsive Teaching*

There are six assumptions that went into the development of the *Framework* that influence the structure of the resultant NGSS and frame how science teaching is to be viewed for the contemporary classroom. These range from an understanding that children (really, all people) are natural investigators who make sense of the world around them
using evidence and reasoning to an awareness of the diverse experiences of our population. *The Framework* was developed using an awareness of how people learn (as discussed by the NRC, 2000) and connecting this to authentic scientific practice. For example, the assumptions that “understanding develops over time” (p. 26), “science and engineering require both knowledge and practice” (p. 26), and we should be “connecting to students’ interests and experiences” (p. 27) all suggest that science teachers should be identifying ways to connect learning to what students already “know” and how science works, using a process that encourages students to reassess and reevaluate their own learning. The sixth assumption ties teaching and learning together by putting it onto the shoulders of educators to identify and focus in on “core ideas and practices” (p. 25). As described previously, this last assumption is the NGSS (NGSS Lead States, 2013), which represents a repository of both content and practices that students need to understand to be successful in science and beyond. What isn’t explicit in the standards or *Framework* (NRC, 2012) is how these assumptions should be enacted. This is where responsive teaching comes in.

Responsive teaching (Robertson, Scherr, & Hammer, 2016) is the outcome of a set of beliefs about learning that allows for the recognition of student preconceptions and experiences as building blocks for learning. Responsive teaching is related to the concept of noticing (described in more detail in the next sections; see also Robertson, Atkins, et al., 2015). Where noticing describes a set of skills, responsive teaching focuses more on the relationship between what students are doing and what the teacher needs to be
thinking about, with particular attention to the outcome of the decisions the teacher makes once they have observed students and deciphered their work (Robertson, Atkins, et al., 2015). It is because of this focus on outcome over process that I have chosen to use the term noticing over responsiveness for this dissertation; however, the two are not that different and certainly either can be used as a reference point for examining the development of effective teaching skills in novice teachers. In the next section, I will provide more details about noticing, its origins and role in mathematics and science education.

**Noticing**

As identifying and interpreting student ideas is at the forefront of contemporary teaching practice, it is important to examine these skills more carefully. For approximately the last decade, mathematics education researchers have framed the interface between teachers and student thinking around the concept of mathematics teacher noticing. One specific form of this noticing practice that has gained popularity is what Jacobs et al. (2010) refer to as professional noticing of children’s mathematical thinking (or simply, “noticing”). This specific form of teacher noticing is more than merely the idea of an object or idea coming to the teacher’s attention but extends to the complex interplay between student response as a demonstration of student thinking, bringing the teacher’s attention to the student’s thoughts, interpreting those thoughts, and then formulating some pedagogical response. Or, what Jacobs et al. (2010) simply describe as the “attending to”, “interpreting”, and “responding to” student thinking.
Noticing, in this way, comes from research on expertise (NRC, 2000) and situation awareness (Endsley, 1995; Miller, 2011). In the everyday hustle and bustle of the classroom, teachers need to be able to focus their attention on the events and actions that are most important. The ability to take in the entirety of the classroom, home in on only the most useful information, and evaluate the effectiveness of the lesson during the enactment of the lesson is a hallmark of expert teachers (Berliner, 2001). This suggests it is an important skill set that novice teachers need introduction to early on, and then encouragement to continue to develop throughout their careers.

There are many arguments for why teacher noticing of student thinking is of value, in addition to being a trait of teacher expertise. One of the guiding principles of mathematics education states that effective teaching “involves creating, enriching, maintaining, and adapting instruction” in such a way that students are actively part of the mathematical learning environment (NCTM, 2000, p. 18). In order for teachers to be able to adapt their instruction to meet the needs of students, they need to first identify and interpret student understanding of the material. Science teachers are called upon to “press students to explain, critique, and revise their ideas as they explore phenomenon,” but the explicit role of teachers in doing so is not yet clear (Windschitl & Barton, 2016, p. 1105). The ability for teachers, regardless of content area, to guide students effectively through the process learning hinges, in part, on the very skills included within teacher noticing.

*Noticing in mathematics education.* Mathematics teacher noticing, as described above and by Jacobs, Philipp, and Sherin (2011), stemmed from research interest in
expertise and a desire to understand how it manifests in the classroom (NRC, 2000). As a result of the varied interpretations of how teachers express and develop expertise, there is a diversity of perspectives about what constitutes noticing, many of which are illustrated throughout the book, *Mathematics Teacher Noticing: Seeing Through Teachers’ Eyes* (M. G. Sherin, Jacobs, & Philipp, 2011). Some researchers focus on only the act of attending to situations in the classroom, whereas others focus on interpreting what students are thinking. Regardless of specific moment of focus, all of the studies describing mathematics teacher noticing tie it to the dynamic classroom context, an in-the-moment activity performed by teachers amid the ever changing and often distraction-filled teaching environment. As B. Sherin and Star (2011) explain, during this “blooming, buzzing confusion” (p. 73) it is important that teachers are able to identify and focus in on those momentary pieces of information that give insight into student thinking, while also balancing attention to other behaviors that need attending to as well.

Aside from the challenge of coming to an agreement about what noticing is, there is also debate about the best methods for studying and making sense of teacher noticing. After all, it is impossible to continuously ask teachers to explain their choices in the middle of teaching a class. For this reason, much of the work performed in mathematics teacher noticing has been through the use of video of their own and/or others’ teaching, usually as a way to elicit teacher thinking about both their own teaching and teaching generally. Use of video affords the researcher (and teacher educator) opportunities to examine the thought process teachers are capable of having around noticing practices but
sets a limit on how far one can carry these assumptions into the act of teaching (M. G. Sherin, Russ, & Colestock, 2011). For this reason, it is important that researchers use a wide range of study designs to explore noticing practices.

Up to this point, many studies have been primarily intervention-based. Notably, Philipp et al., (2007) used what they called a “laboratory approach” to learning to teach, as opposed to the traditional apprenticeship. In this experimental/interventional study, they show that explicit introduction of paying attention to mathematical thinking through video results in more reflection about student thinking, but also show a qualitative change in perspective about why teachers should learn to think about mathematics from a student’s viewpoint. Similarly, Santagata and Yeh (2013) show that introduction of a highly specialized video-based course focused on preservice teacher attention to student thinking resulted in greater ability to design lessons that enable better noticing of student thinking. Both of these papers suggest that there is a great deal of value to introducing preservice teachers to the idea of noticing student thinking, but also beg the question as to how else teacher education programs can introduce noticing effectively. This last is especially important for programs that rely heavily upon apprenticeship/field experiences, such as is the case for teacher residency programs.

Mathematics education research around teacher noticing provides intriguing information that has implications for other content areas. In terms of science education, there is room to explore how science teachers develop and integrate noticing practices while also engaging students in both learning science content and science practices. The
former has more parallels to the mathematics content that is typically of concern in mathematics noticing literature, but the latter has the additional challenge of confusing practices with being purely procedural, despite the practices being at the heart of an intellectual endeavor.

*Noticing in science education.* In science education, noticing as a framework has not gained popularity yet, but there are several examples of science education studies that suggest this framework is as valuable in science as it is in mathematics. Levin et al. (2009) argue that “teachers can only assess student reasoning if they are paying attention to it” and that teachers need to learn to “attend to—and assess—ideas and reasoning” (p. 143). The authors also suggest that rather than looking at teachers from the perspective of going through stages of development, researchers and teacher educators should be looking at specific skills that need developing, in this case, teacher attention to student thinking. To explore this idea, the authors observed teaching “interns” who were working part time as teachers while also taking teacher education courses. The focus of their study was during the science methods seminar-related work. The authors found that there was a great deal of variety in their participants’ use of attention to student thinking in the classroom and that they generally had a basic ability to attend to student thinking even early on in their teaching experience. Similarly, Barnhart and van Es (2015) showed that preservice teachers are capable of various levels of sophistication when engaging with noticing practices, especially following use of a video-based intervention. These findings negate the prevailing theory that teachers first begin with a general focus on management
and curriculum and then eventually progress to focusing on student thinking. Further supporting this, when Levin et al. examined more thoroughly the contextual influences of preparation and site, they noticed that the intern with the least ability to focus on student thinking (she was capable, but chose not to) had, in fact, not taken the same preparatory course that included a more student-thinking focused curriculum and worked in a school that prioritized classroom management as being most valuable to focus on in beginning teachers. Together, the observations made by Levin et al. and Barnhard and van Es suggest that it is valuable to change the focus of teacher education programs from only attending to behavior and routines, but to press new teachers to also consider student thinking. These studies leave open the door to examining how different teacher education programs frame and balance curriculum, management, and student reasoning, as well as how field and university-based experiences are managed in symphony to support laying the foundation for teacher growth in all of these areas. This collaboration between university courses and field experience is particularly important in residency and alternative pathway programs for teacher education.

Teacher noticing is also examined, but not named, by Smart and Marshall (2013), who used a mixed-methods design to examine the relationship between teacher questioning techniques and student cognitive engagement during inquiry. They show that low-demand (procedural) questioning results in lower cognitive engagement by students and high-demand probing is correlated with deeper thinking practices by students. However, they frame their findings in a socio-cultural framework that suggests this is
primarily related to agency and peer modeling. These findings fit well into professional noticing as good teacher questions can be the result of teachers being attuned to their students’ thinking and needs, and not merely, as these authors suggest, personal reflection of teaching practices.

A related issue that has come up in science teacher education research is the use of different formative assessments such as using written work to assist with the evaluation of student understanding of science content (Talanquer et al., 2015). Although written work is outside what mathematics education researchers typically examine as part of the noticing framework (which primarily focuses on in-the-moment noticing procedures that require rapid decision-making processes), it is relevant in terms of engaging in reflective teaching practice that teachers need in order to adapt and design curriculum in response to student needs. It is important to note that professional teacher noticing of students’ thinking is a form of formative assessment. Noticing is but one of many ways teachers can and should be evaluating student learning. The fact that it is based in the dynamic and sometimes chaotic context of classroom discourse that has competing demands for attention makes it particularly valuable to research. Research such as Talanquer et al.’s on student written work is useful for helping to draw connections between what teachers see in-the-moment and student work when they are able to devote more time to outside of the buzz of the classroom setting. Because of the competing needs of attending to behaviors and comprehension and the evidence that novice teachers tend to focus on procedural understandings (Thompson, Windschitl, &
Braaten, 2013), it is especially important that teacher educators understand how teachers notice student thinking so that they are better able to instruct new teachers in developing this skill.

A major challenge to using teacher noticing as a framework in science is the fact that our teaching force does not have a sophisticated understanding of the nature of science or key science content (Bell, Mulvey, & Maeng, 2016; Hashweh, 1987) and struggles to bring excellent curricula and expert science knowledge to the classroom, which effectively means we are stuck in a causality dilemma. Science education researchers agree that science is more than a collection of facts, the reality remains that there are discrete conceptual pieces that students need to learn in order to achieve science literacy. It is out of this tension that the Next Generation Science Standards (NGSS Lead States, 2013) were born (see above, “Content: Next Generation Science Standards”). The question this dissertation is concerned with is less what do students need to learn, but how do their future teachers learn how to implement effective pedagogical practices that support these standards.

Theoretical Framework

Situated learning (SL) theory acknowledges that learning may be internally processed, but the true nature of what is learned is socially and physically defined and delimited, and thus enacting knowledge is dependent upon context (Lave & Wenger, 1991). Knowledge is therefore embodied in both the people and the objects involved in the learning context. Situated learning describes learning as apprenticeship or relational,
and dependent upon access to a community and context in which the practice being learned is used. In this way, learning is highly specialized, tied to context and social relationships. In terms of teacher education, the specific case of situated learning context is one that makes up a “cognitive apprenticeship” (Crawford, 2007; Wenger, 1998a), where novice, mentor, and instructor all learn from each other through interactions involving theory and practice. The importance of context and relationships in SL provides a useful framework for understanding how science specialists learn to become science teachers. On a practical level, it highlights the value of engaging in field experiences. But it also provides an analytical lens for examining the specific aspects of all of the contexts that are involved in the process of transforming science specialists into science educators.

Figure 1. Residency experiences within a situated learning model illustrates how I envision the different aspects of the teacher residency used in this study contribute to novice teacher learning about how to engage in noticing practices. The darker the color, the more of an insider or aspect of an insider is suggested. Dark grey symbolize bridges to borders (represented by light grey shading). The darker the color, the more influence these experiences and traits should have on PST learning. The large white arrow indicates the PST moving through the milieu above and below as they navigate learning to notice. In the following sections, I will explore how SL can be used to examine how preservice teachers develop noticing skills as part of their broader development into nascent educators.
Cognitive apprenticeships

Lave and Wenger (1991) explored how apprenticeship provides a specialized context for learning how to become part of a community of practice. In the case of teaching, the community of practice (Wenger, 1998b) includes everyone engaged in educating students. A novice teacher is inducted into this community, usually through a series of field-based experiences. Field-based teaching experiences, often called apprenticeships, internships, or practicums, are important in teacher education. Just as Lave and Wenger’s various apprentices learn through engaging with the communities of practice they are joining, preservice science teachers must become immersed in the rituals, practices, and contexts that define science teaching. Field experiences provide a form of legitimate access to all of the daily experiences and roles of teachers. Methods courses provide opportunities for novices to interact with each other and additional
seasoned professionals (their instructors) while the preservice teachers practice some of the skills they will need as teachers, such as lesson planning and leading instructional units. Residencies, as described below, afford an extended opportunity to engage with the social, cultural, and physical mediators of teacher learning. During a residency field experience, the preservice teacher has almost daily access to a teaching community (their mentor and other staff at their field placement), which provides the PST an opportunity to observe and engage in the social, cultural, and physical aspects of working in public schools. However, it should be noted that this ideal is subject to gatekeeping by mentors and coaches that may inadvertently limit access to necessary experiences (Kolman, Roegman, & Goodwin, 2016). In terms of teacher noticing, if instructors, mentors and coaches do not value these skills, then they will not provide opportunities for preservice teachers to engage in these practices.

Field Experiences

One of the most important aspects of contemporary teacher education programs is the use of field-based experiences in preparing teachers. Often these experiences are in the form of student teaching internships where a preservice teacher slowly takes over the duties of a mentor teacher over the course of a few months. The length of time in the classroom and degree to which the preservice teacher is supported by a mentor teacher varies by program and state requirements. For example, my own teacher education program (a more traditional master’s in education program plus certification) included six weeks of full-time co-teaching, plus one semester (a little over three months) of full-time
teaching. Undergraduate certification programs typically include about a semester of full-time student teaching, wherein the preservice teacher works up to taking on the full course load of their mentor teacher. Many alternative teacher education programs, such as Teach for America, opt to reduce preparation for entering the teaching community of practice and instead are centered around the teaching candidate taking on a full-time teaching load on their own with variable amounts of mentorship and coaching, thus resulting in longer exposure to classrooms, but with limited support. Teacher residencies are somewhere in the middle with a year of full-time field experiences being the centerpiece and university coursework integrated alongside these field experiences (Darling-Hammond, 2000; Guha et al., 2016). The main difference between a residency and other teaching programs of similar length is that the residency is designed in a way that attempts to more directly integrate university classes and field experiences, with a major focus being on what the novice teachers are experiencing in the field. Thoughtful planning of university courses can make for a more direct connection between theory and practice that extends to the university and isn’t merely left to mentors and coaches to explain. In all of these cases, the field-based experiences are different forms of cognitive apprenticeships (Dennen & Burner, 2008). All three program types include at least some field-based experiences, which means at least for that time, the preservice teachers have an opportunity to integrate themselves into and learn from real school communities. Residencies, however, make this connection explicit. The residency used in this study built these connections explicitly through careful planning of course work, an in-depth
selection processes for mentors, ongoing training for mentors, and clear program expectations and goals that are laid out before residents start their field experiences.

An important feature of field experiences as cognitive apprenticeships is the novice teacher having access to members of the community of practice in question. These insiders are master teachers who serve to model and guide the novice as they gain access to the community of practice (Wenger, 1998a). Relevant to this study, two types of insiders engage with the PSTs. The most important insider is the cooperating teacher, or mentor, who provides direct and immediate physical and cognitive access to a classroom. The mentor provides the legitimate access to the community of practice and associated environment, but also acts as a gatekeeper who determines how much direct access the PST receives. The type support for and degree of impact on student teachers by mentors varies (e.g., Ambrosetti, 2010; Hall, Draper, Smith, & Bullough, 2008; Rajuan, Beijaard, & Verloop, 2007), but from a situated learning perspective, their role is invaluable.

Coaches (or sometimes “university supervisors”) are the second type of knowledgeable insiders. Coaches are employed by the teacher education program to both evaluate and support the development of PSTs. They typically have teaching experience, providing an additional perspective on the ins and outs of teaching. Coaches are significantly different from mentors in that they do not provide access to a specific teaching community and are often the main evaluators of PSTs, providing a bridge between the program and the school site.
Notably, a large segment of research into preservice teacher education has focused less on the specific experiences of PSTs and more on the role of mentors in providing guidance to their mentees (Cochran-Smith et al., 2016). And this research, in turn, is often in terms of examining the ability and process of mentors to impart skills and teaching beliefs to the student teacher (Garza, Duchaine, & Reynosa, 2014; Goodwin et al., 2016), and have mostly ignored the role of other experiences or the interplay between experiences in the learning process of preservice teachers. If learning to teach were only about memorizing skills and perspectives, then the practicum would not be of much use. Instead, as described by (Zeichner, 2010) and implied by the increase of funding opportunities for reform-based teacher education programs, there is a push to not only increase the amount of time preservice teachers are in the field, but improve upon how these field experiences integrate into programmatic experiences (Darling-Hammond, 2010). Situated learning is a compelling framework for examining the limits of existing teacher education programs, while also maintaining focus on preservice teacher experiences and trajectories during their transition into becoming teachers. In terms of professional teacher noticing, this set of skills is something that preservice teachers should learn about explicitly from instructors of their methods course, and then encouraged to practice and reflect upon this skill by their mentors and coaches.

University Courses

Another aspect of the cognitive apprenticeship for preservice teachers are the university courses the PSTs take part in. University courses are not directly part of the
specific community of practice, they are instead on the boundary (Wenger, 1998a), providing access to relevant knowledge and access to resources that enrich novice teachers’ learning experiences. These courses provide theoretical foundations and opportunities to learn specific skills involved in teaching, but also can help induct the PSTs into a community of practice through building peer connections and introducing PSTs to the language and culture of the larger teaching community they are joining.

Content methods courses. One type of course common in teacher education programs is the methods course (or a series of methods classes connected to specific content areas). Methods classes provide preservice teachers opportunities to learn the latest evidence-based practices in a given domain, while also receiving support from experienced educators. However, sometimes the material covered in methods courses is not retained once the preservice teacher enters their own classrooms. For example, despite showing improvement in understanding the nature of science following a specially designed methods course, preservice teachers tended to revert back to their original perspectives a few months later (Akerson, Morrison, & McDuffie, 2006). This suggests that we need to do better to define and use best practices that encourage and support long-term assimilation of the valuable information introduced.

As discussed above, methods courses also provide researchers and teacher educators opportunities to use a variety to techniques to support preservice teacher learning (e.g., video-based discussions around noticing student thinking). Additionally, methods courses can provide opportunities for in-depth discussion that will not be easily
available once preservice teachers enter their own classrooms. It is in these classes where teacher educators can provide students opportunities to practice and receive feedback about specific skills. There are a variety of ways to do this; for example, lesson study such as the ones described by Amador, Carter, Hudson, and Galindo (2017) gives preservice teachers an opportunity to observe each other in real-time, but also slow down the reflective process such that they have time to make sense of what works and what doesn’t, and internalize that information for themselves. However, there is no definitive or even consensus method of teaching teachers, with suggestions ranging from democratizing teacher education courses (Zeichner, Payne, & Brayko, 2015) to incorporating explicit instruction around desired orientations (Windschitl & Thompson, 2006). Therefore, methods courses are very important components of the cognitive apprenticeship experience in teacher education, providing access to foundational knowledge, but also framing use of that knowledge for the novice teacher.

Teaching seminar. Another type of course observed during this study is a teaching seminar. This course is an opportunity for preservice teachers to reflect upon their field experiences, share resources with peers, receive feedback on pressing dilemmas, and connect with another experienced teacher mentor. This course explicitly supports the development of reflective practice skills, which may be important for long term success and growth of teachers (Beauchamp, 2015; Loughran, 2002).

Other courses. Although the specific courses or workshops required by programs vary, there are often opportunities to learn about the mental and emotional development
of students, how to integrate technology into the classroom, or courses on working with specific populations of learners (e.g., English language learners). Most relevant to this study, during the semester prior to student teaching, the program of focus requires preservice teachers to take a child and adolescent development course. As middle grades educators are reentering the world of adolescence, albeit with the perspectives and knowledge gained from years of experience, it makes sense that they also learn about how children’s abilities and capabilities develop. This course provides the novice teachers some perspective on the behaviors they see in the field and context for considering how to best approach teaching adolescents.

Together, these courses provide preservice teachers both access to the theoretical knowledge that underlies how teaching works, but also why it works and opportunities to practice and reflect on what they have learned. As preservice teachers take these courses together, they also build networks of relationships that provide them opportunities to gain feedback and provide feedback to others, which reflects how situation learning theory suggests people learn the skills and knowledge needed (Korthagen, 2010; Lave & Wenger, 1991; Wenger, 1998a).

Summary

The Present Study

I have outlined various factors that either influence or directly impact how science teachers (and to a lesser extent, math teachers) teach. This dissertation acknowledges the
interplay between teacher beliefs about teaching, learning, and doing science, authentic experiences, and role of methods courses in the classroom. Based upon this information, this dissertation answers the following research questions:

1. What professional noticing practices do preservice science teachers (PSTs) learn about, observe, and engage in when interacting with student ideas and work in science?
2. How do PSTs’ engagement with noticing practices develop over the course of the semester?
3. Given access to similar university-based experiences, how does domain of specialization (math versus science) relate to PSTs attending to student thinking?

This study examined the common and uncommon experiences different preservice teachers have access to and respond to as they learn to address student thinking. This work was based in part on the conceptual framework defined by Barnhart and van Es (2015) and modified by Amador, Carter, and Hudson (2016), wherein the authors define not only the types of (in their cases, mathematical) thinking preservice teachers notice, but also the sophistication with which they enact each skill within in teacher noticing. Amador et al., (2017) used this conceptual framework during a case study of a teacher from her preservice through initial professional teaching practice, which appears to be among the first study to use this conceptual framework in science teaching as well as mathematics. Amador et al. (2017) found evidence that the teacher they were studying had changed in her ability to attend to, interpret, and respond to student thinking in both
math and science, but it remains valuable to examine patterns in exposure to and engagement with noticing practices throughout the varied experiences of a variety of preservice teachers. Although my dissertation is similar, it is highly focused on a smaller time scale (one semester) and over more contexts (several preservice teachers in different teaching locations). Through use of Situated Learning as a theoretical framework, my study provides a deeper examination into what aspects of teacher education programs are influencing the development of these skills, especially in the context of programs that do not already rely heavily upon video-based programming, which is the norm in teacher noticing research within the mathematics education domain.

Implications and Importance

Examination of professional teacher noticing in science has a lot of value in terms of its potential to unite different perspectives on what is most important for science teachers to learn during their education courses. But it also has the potential to provide a framework for refocusing how teachers and teacher educators talk about student thinking. Teacher noticing provides clear boundaries for referring to classroom discourse, where there are distinct skills for different moments in a teacher’s decision making about how to direct the class. When novice teachers learn to attend to moments when students share their ideas, they can more easily be shown the connection to how they interpret those ideas and what pedagogical choices they have available to them in response. By providing a clear framework for discussing the student-teacher interface, noticing opens the door to flexible thinking and clarifies where expertise can develop.
This study examines more deeply whether and/or how a particular teacher education program integrates theory and practice for a subset of its middle grades preservice teachers. Although teacher noticing may be only one of many useful skillsets, it has the potential to impact student achievement. Using a situated learning framework to examine how often and how well novice science teachers are engaged in or offered opportunities to observe the noticing of student thinking, this work provides a specific frame for identifying those aspects of methods coursework and field experiences that contribute to the development of reflective practices of teachers throughout their careers.
CHAPTER 3
METHODS
Overview and Aim of Study

This multicase study examined how preservice teachers develop and enact professional teacher noticing skills (defined in Chapter 1 and described in detail in Chapter 2) throughout the semester prior to their entering into full-time student teaching. Six cases were used to examine individually the experiences of preservice teacher within their own contexts, as well as the shared experiences of the collection of cases as a whole. The aim of this study was to explore the relationship between methods course work, field experiences, and mentorship in the development of professional teacher noticing skills in preservice teachers.

Research Approach

The scope and features of case study are explained by Yin (2014) using a two-part definition. Per the first part of the definition, this study describes “a contemporary phenomenon” where “the boundaries between the phenomenon and context may not be clearly evident” (p. 48). The scope of this study focuses on the phenomenon of professional teacher noticing in science classrooms, which is a context-driven phenomenon, but also experienced and learned through exposure in multiple contexts. I have found it useful to think about the scope of this study in terms of balancing the individual experiences of my cases with the perspective of viewing the cases as part of a whole. To Stake (2006), this broader perspective, a collective look at the cases as part of a
whole, can be referred to as a “quintain,” or the “object or phenomenon or condition to be studied” (p. 6). It is the interplay between the individual cases and the quintain that will drive the analysis for this study.

The second part of Yin’s (2014) definition acknowledges, “there will be many more variables of interest than data points” (p. 49). Results of case study rely upon “multiple sources of evidence” requiring triangulation, but also “benefits from the prior development of theoretical propositions to guide data collection and analysis” (p. 49). As this last point suggests, Yin’s view of using case study in knowledge construction allows for confirming pre-existing hypotheses, not just hypothesis development. As such this reflects my own interest in exploring the real-world experiences of preservice teachers around a particular theoretical construct. In this case, I based my study on the hypothesis that preservice teachers learn to engage in professional teacher noticing through cognitive apprenticeship during methods courses and field experiences. I examined how much preservice teachers explicitly draw from their mentors, peers, and courses as they learn to be professional teachers. But I also wanted to see if I could identify other implicit factors or confounders that may have influenced whether these preservice teachers take up different aspects of noticing skills.

As a pragmatist, I can see an argument for exploring the enactment and development of preservice teacher skills around identifying and making sense of student ideas in a more open and free form. However, given the current state of science education research around this skill set, it makes sense to examine how well noticing applies in a
natural context where noticing is not necessarily the primary goal, but represents a small part of the many skills preservice teachers are exposed to and observed for. This is particularly important given the dynamics of classrooms and the ongoing decisions that need to be made by teachers. Admittedly, video analysis offers some additional affordances for identifying a wide range of noticing opportunities and actions that field notes do not. However, given the limitations set forth by the district in which this research was conducted and what I see as a need for generating utilitarian methods for clearly identifying noticing in situ, I see case study as responding to some of the suggestions made by (Lineback, 2016). For example, she describes a system of characterizing events that speak to a teacher’s responsiveness that is reminiscent of the critical incident technique described by Butterfield, Borgen, Amundson, and Maglio (2005), where a convergence of data provides suggestions for important focal points. In this study, I used my professional experience, research goals, and feedback from participants (both primary and secondary, as described below) to generate a rich collection of data that describes multiple snapshots of primary participant teaching actions. I was able to collect such rich data because of my role as an observer-as-participant (Kawulich, 2005), where I was able to engage with participants on many levels in a variety of contexts and build their trust. In order to yield a strong conclusion about how and why preservice resident teachers develop and use noticing skills, Yin’s (2014) and Stake’s (2006) perspectives on case study are well suited to this study and provide a framework for examining its strengths and weaknesses.
The theory of professional teacher noticing describes a process of identifying moments of engagement with material, interpreting students’ behaviors in the context of those students and typical learning trajectories of the topic, and then responding appropriately in such a way that students’ learning is enhanced (Jacobs et al., 2010). Preservice teachers are likely encountering this concept (teacher noticing or responsive practice) for the first time during their methods courses and associated field experiences. This study followed a replicative, holistic multiple-case study design in order to better explore the experiences preservice teachers have in relation to noticing student thinking. As Yin (2014) warns, case study is not meant to be used to determine frequency of a particular phenomenon, but rather explore the context of the phenomenon. To this point, although my research questions ask about the timing of engagement with professional noticing practices, they do not assume any generalizability beyond the contexts provided, except in the sense of cross-case analysis between each case and between the cases and the quintain as a whole, but rather provide suggestions as to what factors are potentially important to consider in other teacher education contexts.

The data collected (described in more detail below) for this study is meant to represent the “ordinary happenings for each case” (Stake, 2006, p. 29, emphasis in original). To this end, as much context-based evidence was collected as possible. Multiple forms of evidence were gathered to provide a broad and detailed a view into the experiences each preservice teacher encounters. For overlapping contexts (such as if all participants are from the same methods course and are assigned to the same field
placements), the types of data available were fairly similar, with variations depending upon the situational needs of the participant. For the unique situations experienced by each participant, the types of data were driven by what each context and specific observation opportunity had to offer. This ranged from different forms of feedback by other actors to different site-based policies that influence lesson planning and engagement with student thinking (e.g., entry tasks about content were regularly used in some classrooms, but not others), to differences in availability of notes and levels of detail available in assignments gathered.

Interviews and field observations (described in more detail below) were most substantive sources of data, which also means that the coding process during observation and during analysis of each interaction potentially influenced the types and amount of data available. As Stake (2006) points out, the data sources need to fill in information not only about what the researcher can see for themselves, but also what only is observed by others.

Case study analysis and data collection are tightly intertwined. Although the quantitative ideal is for each piece of data to stand on its own, qualitative case study data collection includes data coding—often completed throughout the process of data collection. This iterative process of data collection and analysis allows more latitude for interpretation and opens the door to a deeper and potentially more meaningful analysis. In the case of this study, ongoing coding and use of reflective memos resulted in not only distinct codes relating to noticing, but also broader themes that describe contextual
factors that appeared to play a role in the development of how much participants attended to student thinking, such as “mentor values student engagement in critical thinking.”

Data for each individual case was coded and analyzed separately, but also examined using a cross-case analysis protocol (Stake, 2006). Multicase studies can be presented as a compilation of intact, individual cases, “[accompanied] by a cross-case analysis” or as part of a whole where only “the binding concept is developed” (p. 8). Considering that I was the sole researcher, responsible for gathering data for all of my cases during an overlapping time period, it is important to note that although my intention was to examine each case in line with each research question on its own, the iterative process and the fact that data collection for all cases was contemporaneous means that it was impossible to fully separate analysis of one from the other. Therefore, the final synthesis of findings reflects more accurately the quintain, with the cases used as examples of the particular. All analysis followed what Yin (2014) refers to as “analytic generalization,” where the conclusions drawn reflects the replicative nature of the findings based on the cross-case analysis, but will not hold statistical strength such as to be statistically generalizable (pp. 78-79).

Settings

The settings for this study were determined by the locations associated with each participant as relevant to the primary participants’ experiences within their teaching program. Participants are described in the next section of this chapter.
This study took place in a mid-Atlantic (MA) city within a large research university with several teacher education programs and partnerships with two school districts. The [MA] School District (MASD) and [MA] Charter Schools (MACS) are public districts housed within the same city. This study involved data collection at the university during four courses, two school sites within the MASD, and one MACS where field experiences for the methods courses took place.

**Recruitment Site**

The university has multiple teacher preparation programs leading to certification in science teaching in grades 4-8 (middle grades) and 7-12. Programs range in scope and scale from small specialized graduate programs to larger, comprehensive undergraduate programs. Different programs also have different post-completion goals, ranging from no post-graduation requirements to a requirement that recent graduates to teach in the local urban public and/or charter schools for three years following graduation. Overall, students enrolled in the middle grades and secondary teacher education programs at this university are a little over half female (54.3%) and predominantly White (76.0%) (personal communication with [MA] College of Education’s dean’s office, December 2018). It is noteworthy that although these programs are generally more diverse than national trends in teacher demographics (e.g., the university’s programs are 76% White versus the national average of 82% White), they still are not in line with the K-12 student populations of the area, where only about 14.5% students are White (Bond, Quintero, Casey, & Di Carlo, 2015; [MA] Department of Education, 2018).
One program, [MA] Teacher Residency (MATR), was selected as the focus of this study because of the potential to follow multiple preservice teachers through parallel experiences for up to the length of an academic year. With a focus on specifically responding to the local urban district’s needs for teachers who are highly qualified to teach mathematics and science, the MATR is unique among the university’s programs. MATR is cohort-driven, field-based, and accelerated. This residency program was initially designed to prepare middle grades mathematics and science instructors; however, the current cohort also includes a small sub-cohort of preservice secondary teachers. MATR students, or residents, are selected once per year and move through the program as a single cohort, with common course work and expectations. All residents are partnered with an experienced mentor teacher, with whom they co-teach four days a week from the first week of school in August through the end of June. This program has high expectations, requiring students to complete the requirements for both certification and a master’s degree in a calendar year. MATR students also receive significant tuition reduction and a living stipend for their commitment to teach mathematics and/or science in the local district for three years following graduation. On average, this program has been 60% female and 58% White. Residents in the cohort from which the study population was drawn were 65% female, 10% African-American, and 70% White.

Courses

Throughout the study period, data collection was performed in multiple locations, one subset of which were in the four university-based courses residents took. The courses
included science methods, math methods, teaching seminar, and child and adolescent development. Observations were made about the topics covered, key discussion points made by participants, and alignment between courses and the program goals. This information was informative for multiple reasons, the most important of which was to determine how and when student ideas about content were discussed. Permission to observe the courses was obtained from each instructor prior to the start of the study.

Field Placements

Two school districts are included in this study as primary and secondary data collection sites due to the fact that although residents in MATR are all placed in the city’s public school district for their residency, the mathematics and science methods courses include field experiences in a nearby public charter school. The population of the urban schools in the region are primarily African-American and Hispanic and come from economically disadvantaged backgrounds ([MA] Department of Education, 2018).

[MA] School District (MASD)

There are approximately 130,000 students enrolled in MASD public schools ([MA] Department of Education, 2018). The student population is approximately 49.7% Black, 20.0% Hispanic, and 14.5% White ([MA] Department of Education, 2018). Almost all of the schools in this district are Title I schools, where 91.4% of students are considered economically disadvantaged ([MA] Department of Education, 2018). Title I schools, where at least 40% of the student population is considered economically
disadvantaged, receive additional federal funding and support above and beyond other federal, state, or local monies received (U.S. Department of Education, 2015).

Within the MASD, the residency program currently only uses a small subset of schools. This study focuses on two in particular. Overall, the potential residency schools are 32% Black, 31% Hispanic, and 19% White ([MA] Department of Education, 2018). The two schools that made it through the winnowing process described in the next section (Participants), were 45% Black, 13% Hispanic, and 28% White ([MA] Department of Education, 2018).

Residency site one. The first school, referred to in this dissertation as [MA] School District East (MASDE), is about 22% Black, 20% Hispanic, and 44% White. Most of its approximately 400 middle grades (6-8) students are from the neighborhood surrounding the school and are economically disadvantaged (99%; [MA] Department of Education, 2018). Admission is through a district wide lottery system, however there are a couple contributing factors to the fact that most students come from the surrounding neighborhood. First, the school can be challenging to get to from anywhere outside the neighborhood due to limited direct public transportation routes. And second, the surrounding neighborhoods are considered less desirable—on a personal note, I had to rely upon taxis to get to the school and quite often a driver would remark about how dangerous the neighborhood was or comment on the homeless camps for those mainly impacted by the opioid crisis. Despite these warnings, I never felt in danger, but did notice the state of disrepair much of the area was in. The school straddles some industrial
areas, which adds to the impression that this is not a good area. However, this school is recognized as being good; one cab driver mentioned they were disappointed when they were younger and had to move out of the neighborhood before attending this school. The school building has a historic designation, and therefore has many quirks unique to old buildings, such as slanted floors and awkward layouts of classrooms that were not originally designed with modern technology in mind. The only outside time students get is at lunch and only on the pavement of the parking lot for the building.

Residency site two. The second school, [MA] School District West (MASDW), was another lottery-admission school, however approximately one-third of the slots are filled by students with special needs. This school is a very small K-8 school, where its approximately 300 students are 83% Black, 3% Hispanic, and 2% White. Interestingly, unlike other schools in this district, zero percent of the students are Asian ([MA] Department of Education, 2018). Like the school district MASDW is housed in, a vast majority of its students are economically disadvantaged (95%; [MA] Department of Education, 2018). Similar to MASDE, MASDW is housed in an older building. However, unlike the industrial nature of the surrounding neighborhood of MASDE, MASDW is located next to a park and surrounded mainly by residences. The park is used by the school for recess and as a special treat by teachers who want to reward their students for their hard work. As a result of catering to students with special needs, the school has highly regimented hallway expectations (e.g., students walk from location to location in single-file lines guided by staff) and the principal has implemented several adaptations to
the schedule that result in small class sizes for some courses, such as the grades 7 and 8 science classes observed for this study.

[MA] Charter Schools (MACS)

During the methods courses, participants engaged in field experiences at one of the local charter schools. As of the writing of this dissertation, this public charter organization consists of four schools that are 46.5% Black, 28.1% Hispanic, and 13.5% White ([MA] Department of Education, 2018). This year, the methods course-based field experiences were held at MA Charter School A (MACSA). MACSA is 43.7% Black, 29.2% Hispanic, and 13.2% White ([MA] Department of Education, 2018). MACSA is a relatively new building with three sections—one for elementary, one for middle grades, and one for high school. All field work at MACSA occurred in a math and a science classroom in the middle grades section. Admission to MACSA is limited primarily to students who have attended one of five schools in the area. There are no academic requirements to attend, and if more students apply than there is room, a lottery is run to select for admission. The school is surrounded by a locked and monitored gate. Young students are walked across the street to half of the guest parking lot for recess. Middle grades and older students do not have recess.

Participants

A multiple-case study design, including development of appropriate assertions and pursuing theory exploration, requires 4-10 participants. A purposeful sampling method (Creswell, 2013) based on a common criterion is ideal for examining the
phenomenon of preservice teacher enactment and experience with professional noticing skills, as only members of this group of people are relevant to this study. There are four groups of actors involved in this study, two types of participants and two types of non-participants. I recruited and followed six preservice teachers, their six mentors, and their university coach (all six preservice teachers were assigned the same coach). The following subsections describe the roles and general characteristics of these different actors, and a summary of applicable traits for the residents and their mentors are listed in

Table 1. Resident and Mentor Characteristics

<table>
<thead>
<tr>
<th>Pseudonyms (Resident/Mentor)</th>
<th>Content Area for Degree Program</th>
<th>Mentor Years of Experience</th>
<th>Grade &amp; Content</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luke/Ms. Childs</td>
<td>Science</td>
<td>19</td>
<td>7/8th Science</td>
<td>MASD East</td>
</tr>
<tr>
<td>Jason/Mr. Waters</td>
<td>Science</td>
<td>9</td>
<td>6th Science/Social Studies</td>
<td>MASD East</td>
</tr>
<tr>
<td>Janice/Ms. Gilmore</td>
<td>Mathematics</td>
<td>5</td>
<td>8th Mathematics</td>
<td>MASD East</td>
</tr>
<tr>
<td>Anthony/Mrs. Hartman</td>
<td>Mathematics</td>
<td>10</td>
<td>6th Mathematics</td>
<td>MASD East</td>
</tr>
<tr>
<td>Estelle/Ms. Mary</td>
<td>Science</td>
<td>13</td>
<td>3rd/4th Science/Mathematics</td>
<td>MASD West</td>
</tr>
<tr>
<td>Vale/Mr. Bob</td>
<td>Science/Mathematics</td>
<td>21</td>
<td>7/8th Science</td>
<td>MASD West</td>
</tr>
</tbody>
</table>
Primary Participants

The six primary participants, the preservice teachers, range in age from 24 years to 35 years and are members of a graduate teacher education program at a mid-Atlantic university. Two teach math-only, three teach science-only, and one of the science teachers teach both math and science. One participant is a person of color, whereas the other five are white and non-Hispanic. Four identify as male and two identify as female. Providing individual-level characteristics of participants risks participant anonymity and therefore are not included (Table 1).

All recruitment of primary participants was done in person, at the start of the residency seminar class. Consent procedures were arranged with agreement of the instructor. All twenty members of the class were given an overview of the study’s aims and procedures (observations of methods class and field experiences, interviews, etc.). During the consent process, I shared with the prospective primary participants the purpose of the study, the requirements for participation, potential risks and benefits, and how risks will be minimized. Those who wished to participate in the study were asked to sign an IRB-approved consent document (Appendix A).

As all but one residency students gave consent, I approached their mentor teachers (see next subsection) and principals about inclusion. Participants were grouped by location of field experiences, and the final participants were selected based upon whether each site had at least one science preservice teacher available and the willingness of principals, mentors, and coaches to provide consent for research in their school. As this
dissertation focuses on science teacher development, a priority was made for schools housing an equal or greater number of science residents as compared to math. Schools were removed from selection if there were no science teachers available at the site. The final primary participants were selected based upon their principal willingness to give consent per the school district’s policy, the coaches’ willingness to participate, and the schedules of the coaches so as to limit schedule overlaps. In the end, only two schools fit these criteria within the first three weeks of the semester. I was concerned that adding more sites after this time would result in a bias in the data by losing information about the initial beliefs and missing out on observations of the emerging experiences of the residents in question. Residents who completed the study (all six) were given a small ($100) Amazon gift card.

*Secondary participants*

The actors of this study included the participants themselves (preservice teachers), as well as their mentors, coach, students, peers, and instructors. Of these non-primary participants, only mentors and the coach were interviewed, as they should have had particular insight into the behaviors of the participating preservice teachers. The coach (Coach Nan) who was finally recruited was a first-time coach for the residency and still a practicing math teacher in the area (out of district), with almost a decade of teaching experience. She was also a part time graduate student at the same institution as me, but in a different program. As displayed in Table 1, all mentors had at least five years teaching
experience, and more often than not, greater than ten years of teaching experience (as is the average for MATR mentors).

*Mentor Teachers and Coach*

Mentors and one coach were recruited following initial recruitment of primary participants, as described above. Again, secondary participants were provided an overview of the study that included a description of the time commitment required for their participation (inclusion in the coaching sessions after observations, a 45 minute interview at the end of the semester, plus access to their classroom during their preservice teacher’s field experiences), a description of the risks and benefits, and an explanation of how to withdraw should they choose to following giving consent; they were then asked to sign an IRB-approved consent form (Appendix A). Per the district’s request, all mentors were given an additional opportunity to clearly refuse consent at the time of signing the consent forms through the inclusion of a signature line devoted to this purpose. Mentors and coach were also each provided a small ($50) Amazon gift card incentive for participation.

*Other Actors*

Due to the complex nature of teaching and teacher education programs, there were multiple additional actors who were present, but only observed as part of the context of this study. The main group of such actors were the middle and secondary students in the classrooms where primary participants are teaching. Students present in classes were not true participants, but rather part of the context and therefore were not
interviewed or interacted with directly. Observation of student ideas (i.e., that they shared their thinking) was made only when students were directly interacting with the resident or mentor. As the district was clear that they did not want student information recorded, student questions and work were paraphrased in field notes using a generic code to indicate that a student had interacted with their teacher. The specific identity of the student was not known to me and even when primary participants discussed specific interactions, students were indicated mainly by gesturing to a seat. Any names accidentally mentioned during interviews, despite being asked to respect student privacy prior to each interview, have been replaced with pseudonyms.

The other major group of actors were the non-participant peers of the primary participants and the mentors and coaches who did not participate in this study. I did not directly interact with other mentors or coaches, however, I did cross paths with peers who were influenced by their mentors and coaches. Preservice teacher peers’ and instructors’ actions and interactions were similarly noted anonymously and indirectly in reference to primary participants’ actions and reactions.

Procedures

This study was divided into two parts. The first part was a pilot study, in order to test and practice the protocols for data collection and analysis and followed the same procedure as for the main study, but with a small (two person) cohort and their instructor. The pilot study occurred during the Spring semester prior to the official study period. Pilot study participants belonged to the same demographics and contexts described
above, except drawn only from the non-residency programs. Following the pilot, modifications were made to protocols and submitted to the university’s IRB and the associated districts for approval (see Appendix A for related paperwork). The second part was the formal study used for analysis. This study began in August, following recruitment of the methods instructors of the middle grades science and math methods courses, developmental psychology course, and teaching seminar.

This research study included multiple rounds of observations of and interviews with study participants, as illustrated in Figure 2. Observations occurred in the university classroom settings on Wednesdays and Fridays and at field placements (days varied). Preservice teachers were observed and interviewed throughout the semester (see Table 2 for a list of data collection dates). First, I interviewed the PSTs after recruitment using the semistructured interview protocol about beliefs that I referred to as my Intake Interview, outlined in Appendix B. I observed and interviewed each primary participant about their teaching at three distinct points during the semester—early, approximately midway, and toward the end of the semester—following each observation of their residency-based teaching segment. Mentors participated in these follow-up interviews to varying degrees, but otherwise were not the primary focus of these interviews. Coach feedback was collected during post observation interviews with the primary participants and via her sharing her formal written feedback (see “Formal Observation” under “Artifacts,” below). Sometimes the coach’s discussion with the primary participant occurred before my semistructured interview, other times my interview was integrated into the coach’s
observation debrief, in order to respect the time of all those involved. The mentors were interviewed independently during an Exit Interview that followed completion of all three cycles of observations to capture their overall perception of their preservice teacher’s pedagogical beliefs and ability to enact professional teacher noticing (see Appendix B for the associated semistructured interview protocols). Primary participants also participated in an Exit Interview process that involved a repeat of the semistructured interview used during the Intake Interview, including their response to a different short video segment from an unfamiliar classroom than the one used during their Intake Interview. Memos were recorded at least weekly to summarize my thoughts about what was happening during the study and give the author time to reflect on connections and trends. Coding was continuous and iterative, culminating in a final round of analysis after completion of data collection that included cross-case analysis and generation of overall assertions about the development of preservice teacher experiences with professional teacher noticing during this stage of their teacher education program. A summary of codes and themes can be found in Appendix C.
Figure 2. Outline of research activities for Fall semester.

Data Collection

For this study, there are two main contexts of interest: university and school-site. University contexts are those where preservice teachers are learning about teaching theory, specifically in university-based courses. School-site contexts are where preservice teachers have student contact, specifically during their field experiences. Observations of preservice teachers in both university and school-site contexts and interviews followed protocols suggested by the critical incident technique (reviewed in Butterfield et al., 2005) as a guide to identify examples of situations (“incidents”) where preservice teachers have the opportunity to engage with professional noticing as a concept or tool. To identify these instances, expert observers (i.e., myself, an experienced educator and preservice teacher mentor) took notes on the preservice teacher participants’ actions during their field experiences. Critical incidents included a variety of events that
represent key moments where teachers (pre- and inservice) made a decision about attending to, interpreting, or responding to student thinking. Example of these events include, but are not limited to: coaching by mentor or other teacher educator around a specific event, questions posed by students, answers provided by students, body language indicating student cognitive engagement, and other behaviors as determined by the observer. I then selected two to three specific events to discuss with the PST during their Post-Observation Interview.

The amount of data necessary to describe the common (or uncommon) experiences of preservice teachers in terms of professional noticing depends, according to Yin (2014), on whether there is enough evidence to support my main explanation but also whether it “includes attempts to investigate major rival hypotheses or explanations” (p. 157). In this case, my main hypothesis is that preservice teachers learn to notice student thinking through exposure during and support from methods courses and mentors, and that the amount of attention a preservice teacher gives to student thinking is related to the amount of exposure they are given during their methods courses and related field experiences.

Triangulation of my findings required the use of more than interviews and observations, but also an examination of the academic supports and experiences of the preservice teacher. Therefore, I collected multiple sources of data for the purpose of identifying and contextualizing moments of noticing by the participants: teaching observations by their coach, semistructured interviews with participants and their mentors.
and coach, journal entries and blog posts (for university classes), lesson plans and lesson plan reflections, course syllabi, lecture materials, and handouts. Together these provided a holistic picture of not only whether preservice teachers were noticing student thinking, but also how and when they are instructed to do so and their thoughts about student thinking generally.

*Observations*

Each primary participant was observed throughout the semester, during their university-based class meetings and field-based. All field notes were taken either by hand and transcribed into a Word document or using a program called Nebo (MyScript), on an iPad Pro (Apple) using an Apple Pencil and later uploaded to my computer for analysis. The following sections describe the three types of settings for observations and how observations were organized and performed in each. Unfortunately, although I had permission from the leadership of MACS for my pilot study in the Spring semester, I could not procure written permission from the administration again in the subsequent Fall semester. I had permission to observe alongside the instructor as I was also observing in preparation for teaching science methods the next semester, but not to collect data for this study. Instead, I had to rely upon lesson plans, written reflections, and brief “check-ins” after each methods-based teaching opportunity.

*University-based courses.* I observed university courses to identify how student thinking is framed by the different instructors involved in the program, as well as how the primary participants engaged with thinking about student thinking during this time. I
collected copies of relevant notes and assignments for coding analysis as described below in the section on artifacts. I made note of the types of student thinking discussed, how it was discussed, and in what context it was discussed (e.g., initiated by instructor or preservice teacher). I usually wrote brief reflections immediately following a class and incorporated them into my analysis. Most reflections were written at the end of each observation, however, timing of reflections depended upon the schedule of the courses (some were back-to-back) and when I had an opportunity to reflect on what I had observed.

*Field-based teaching. Noticing* is all about what a teacher does in-the-moment, therefore the most valuable field notes I took were field-based observations about the types of behaviors (i.e., physical, cognitive, social) and content-related talk students engaged in and then whether and how the primary participant reacted or responded (i.e., attended to, appeared to interpret, and responded to). As described above about my interactions at MACS, field notes and interviews were not able to be completed for the observations associated with the methods courses directly. I did, however, receive copies of the rough drafts of lesson plans prior to teaching, revised drafts, and the participants’ teaching reflections. This provided me some insight into what the residents paid attention to in terms of student thinking (e.g., did they pre-plan ways to elicit student ideas) and how well they reflected on these ideas after their lessons and when planning their follow-up lesson.
For the residency-based observations, I took notes in Nebo (MyScript), on an iPad Pro (Apple) using an Apple Pencil, alongside images saved of each page of the lesson plan, to make it easier to compare what was planned with what occurred. I color coded or bracketed reflective comments I made during observations. If there was no lesson plan, then I made notes in Nebo as described, minus the reference material. For the first two observations, participants indicated ahead of time what they planned on doing by email or through a quick check in prior to class. All residents were asked to write a full lesson plan for my third observation, which coincided with their coach’s fourth formal observation.

Field-based mentorship. Following each observation of teaching experiences at residency sites, post-teaching conversations were observed between the primary and secondary participants. After discussing my study with all participants, we decided that it would be best to merge my interview with the coach’s discussion. Therefore, after the first round of observations at MASDE, the coach and I decided to merge our conversations so as to limit overlap of the questions being asked and respect the time commitment of the participants. For example, I would ask my semistructured interview questions as they fit into the discussion the coach was having, if the coach did not ask exactly what I was looking for. Digital voice recording via an application on my phone (Voice Memos; Apple) were used to record these conversations. Recordings were transcribed using a paid program (GoTranscript) and reviewed by myself using their online editing software. As all participants are members of the local school district, the
digital recordings will be destroyed after completion of the study per the school district’s guidelines.

*Interviews*

Interviews are useful for exploring not only the enactment of professional noticing, but also the beliefs of the preservice teacher around the idea of soliciting and responding to student thinking. I performed five sets of interviews with each primary participant and one interview with each mentor (Table 2, and detailed below). I recorded all of my semistructured interviews using an application on my phone (Apple’s “Voice Memos”). These recordings were then transcribed using a paid service, GoTranscript (gotranscript.com). Vocal utterances such as “um” and “like” were removed for clarity, but all other phrasing is verbatim from interviews.

Table 2. Interview Details

<table>
<thead>
<tr>
<th>Phase</th>
<th>Participant(s)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intake Interview</td>
<td>1  Resident</td>
<td></td>
</tr>
<tr>
<td>Observation Interview</td>
<td>2-4  Resident Sometimes Mentor</td>
<td>After Phase 2, interview and Coach debrief were merged to respect time of participants</td>
</tr>
<tr>
<td>Exit Interview</td>
<td>5  Resident and Mentor</td>
<td>Individual interviews</td>
</tr>
</tbody>
</table>

*Intake and exit interviews.* The first type of interview I performed was an Intake Interview that was constructed from Luft and Roehrig’s (2007) Teacher Beliefs Interview protocol and a short video-based assessment of their noticing tendencies. The TBI
(Appendix B) was used to examine the epistemological views of my study’s participating preservice teachers. This was important because their beliefs about teaching and learning likely directly impacted the decisions they made about what is important to learn from their courses, mentors, and coach, while also impacting the choices they made “in-the-moment” during field-based instruction. A misalignment was also potentially interesting to note, as it may have indicated the reliability of the primary participants’ metacognitive reflections about their decision-making process.

The video-based assessment involved the participant watching a short (approximately three minute) video segment of a classroom interaction from the Ambitious Science Teaching video files (ambitiousscienceteaching.org; with permission from Mark Windschitl). A different segment from the same full video (same class, same period, different small group of students interacting with the teacher) was used for exit interview than the intake interview.

The exit interviews for residents were identical to the intake interviews, except for the specific video used. Mentors were also interviewed using the same protocol, however the questions were written to ask them about their resident and not themselves.

Post Observation Interviews. During my field observations I took notes, as described above, about the different interactions residents had within their classroom. I paid particular attention to moments where they interacted directly with students. The coach usually was positioned near me during these observations and provided additional perspective into the “critical moments” I was interested in. After observing my primary
participants in action, I interviewed them about their experiences. I explicitly asked
preservice teachers and their mentors to reflect on the preservice teacher’s classroom
activity. I also pointed out particularly interesting moments that were an example of what
commonly occurred or interactions that stood out as being moments where a course
correction was made by the resident teacher (e.g., they begin to say one thing, but pause
and then start a new statement or question).

As mentioned above, my interviews were intertwined with the coach’s post
observation debrief. We typically took turns, but we each invited the other to step in and
ask questions or provide feedback as seemed appropriate in the moment. Transcriptions
were made of the entire post observation interaction.

Artifacts

I collected various additional artifacts for triangulation purposes (Creswell, 2013).
Artifacts from the methods course were requested from the instructor. The process was
initially arranged during the initial recruitment with the instructor, but finalized after
about a month due to needing to sort out how to best use Canvas (Instructure, Inc.), the
university’s classroom management system. I was allowed access Canvas as a “teaching
assistant” for the methods courses and teaching seminar in order to facilitate accessing
relevant information. This allowed me access to the written work of five of the six
residents in science methods and math methods, and all six participants for the teaching
seminar. I had to separately request the missing materials for the sixth resident because
they were in a different Canvas section as they were officially a secondary preservice
teacher and did not take the math methods course, despite his intention to teach middle grades math and science. Artifacts were also gathered at the time of observations (such as handouts created by the participants or notes taken by participants). These artifacts were collected in person and scanned into a digital format using the JotNot application (MobiTech 3000 LLC) on my iPhone for use during coding.

The artifacts I collected included: syllabi from the methods instructor(s), lesson plans and lesson plan reflections from the participants, lecture notes from the methods classes, notes taken by the participants during the first month of science methods classes, Teacher Observation Forms (referred to as “Formal Coach Observations”) on behalf of the program completed by the coach, copies of online discussion and journal notes written by primary participants, and assignments written for their seminar (child study essays and school/classroom profiles). A complete listing of artifacts collected for each participant and details about completion dates and placement within the timeline of this study can be found in Table 3. I was able to compare my observations of the lessons to what participants said during follow up interviews or in their written reflections they sometimes wrote for their university courses. These data gave me some insight into how much the primary participants engaged in noticing practices and whether or not they were even thinking about engaging with student ideas about content. I was also able to look for connections between what they were doing in the field and what they were learning in their courses or from their coach. This allowed me to better understand their priorities and how these may have impacted the decisions they made before, during, and after teaching.
The exit interviews with the mentors provided me some insight into their values around accessing and addressing student thinking (e.g., the ability to coherently discuss this indicates they value it at least enough to make note of what residents were doing in terms of noticing). Between conversations with the coach, the coach’s formal observations, and the mentor’s interviews, I had significant data to describe how each primary participant viewed and engaged with student thinking.

Table 3. Artifact Characteristics

<table>
<thead>
<tr>
<th>Week</th>
<th>Date Range</th>
<th>Artifact/Assignment/Observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aug 28-Sept 2</td>
<td>Syllabi</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Field notes for all university courses</td>
</tr>
<tr>
<td>2</td>
<td>Sep 3-9</td>
<td>Field notes for all university courses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Math Journal #1 (9/7; Topic: Habits and practices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminar Blog Entry #1 (9/7; Topic: First two weeks)</td>
</tr>
<tr>
<td>3</td>
<td>Sept 10-16</td>
<td>Field notes for all university courses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Science Autobiography (9/13)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formal Coach Observation (9/13; Luke, Janice, Anthony, Jason)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Math Journal #2 (9/14; Topic: Creating tasks)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake Interviews (9/14; Luke, Janice, Anthony, Jason)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminar Blog #2 (9/14; Topic: identity)</td>
</tr>
<tr>
<td>4</td>
<td>Sept 17-23</td>
<td>Field notes for seminar and development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formal Coach Observation (9/20; Estelle, Vale)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[Small Group Observations at MACS, 9/21]</td>
</tr>
<tr>
<td>5</td>
<td>Sept 24-30</td>
<td>Field notes for all university courses</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reflection on MACS Science Small Group Observation (9/27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Complete online commentary about MACS Math Small Group Observation (by 9/27)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Science Content Report (9/30)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Math Journal #3 (9/28; Topic: Productive struggle)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intake Interviews (9/30; Estelle, Vale)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Seminar School Context paper (9/26)</td>
</tr>
</tbody>
</table>
### Table 3. (continued)

<table>
<thead>
<tr>
<th>Week</th>
<th>Date Range</th>
<th>Artifact/Assignment/Observation</th>
</tr>
</thead>
</table>
| 6    | Oct 3-7    | Field notes for seminar and development  
|      |            | Observation #1 (10/4; Luke, Janice, Anthony, Jason)  
|      |            | Formal Coach Observations  
|      |            | MACS Lesson #1 (10/5; reflection and revision 10/7) |
| 7    | Oct 8-14   | Field notes for all university courses  
|      |            | Math Journal #4 (10/12; Topic: Portfolios)  
|      |            | Observation #1 (10/8; Estelle, Vale)  
|      |            | Formal Coach Observations  
|      |            | Seminar Blog #3 (10/12; Topic: Anything) |
| 8    | Oct 15-21  | Field notes for seminar and development  
|      |            | MACS Lesson #2 (10/19; reflection and revision, 10/21) |
| 9    | Oct 22-28  | Field notes for all university courses  
|      |            | Math Journal #5 (10/26; Topic: Dividing fractions)  
|      |            | Observation #2 (10/23; Estelle, Vale)  
|      |            | Observation #2 (10/25; Luke, Janice, Anthony, Jason)  
|      |            | Formal Coach Observations |
| 10   | Oct 29-Nov 4 | No seminar or development  
|      |            | MACS Lesson #3 (11/2; reflection and revision, 11/4) |
| 11   | Nov 5-11   | No seminar or development  
|      |            | Field notes for math and science methods |
| 12   | Nov 12-18  | Field notes for all university courses  
|      |            | Observation #3 (11/13; Vale, Jason)  
|      |            | Formal Coach Observations  
|      |            | Seminar Child Study part 1 (11/18) |
| 13<sup>a</sup> | Nov 19-Dec 2 | No classes  
|      |            | Observation #3 (11/20; Luke, Janice, Anthony)  
|      |            | Observation #3 (11/26; Estelle)  
|      |            | Formal Coach Observations  
|      |            | Seminar Child Study part 2 (11/28) |
| 14<sup>b</sup> | Dec 3-14   | Formal Observations from Coach Observation and Janice’s related Reflection  
|      |            | Field notes for all university courses  
|      |            | Final reflective essays for methods classes |

<sup>a</sup>This period is more than one calendar week long, but is referred to as a week due to a break from university courses while residents were still in the field.

<sup>b</sup>This period is more than a week long in order to include the final examination period with the end of the semester.
Data Analysis

This study used an ongoing coding process that allowed for responsive interviewing during the follow-up, semistructured interviews after each observation block. Throughout the analysis process, in addition to the use of a priori codes based on Barnhart and van Es (2015) and Luft and Roehrig (2007) (discussed below), I developed emergent codes for conditions and behaviors related to how residents interacted with student thinking generally. I also used a reflective memoing process to examine data for themes and trends upon completion of all observations and interviews. Table 4 provides a summary of what data sources were used for data analysis by coding process and the aim of each coding process.

Table 4. Summary of Analytic Methods

<table>
<thead>
<tr>
<th>Analytic Process and Purpose</th>
<th>Data Sources</th>
</tr>
</thead>
</table>
| A priori—engaging in noticing practices or discussion about the act of noticing | Residency observation field notes (and if available, associated lesson plans)  
Post observation interviews  
Responses to video prompt during intake and exit interviews |
| A priori—beliefs/orientations | Primary: Intake and exit interviews with residents  
Secondary (primarily for context):  
Residency observations  
Post observation interviews  
Reflective essays  
Seminar blog entries  
Math methods journal entries |
| Open coding—opportunities to learn about noticing or noticing-related practices (e.g., discussions about formative assessment or using student work to plan next lesson) | University course observations  
University course syllabi  
Post observation coach and mentor discussions (part of post observation interview transcripts)  
Formal coach observations  
Mentor feedback (Janice) |
Table 4. (continued)

<table>
<thead>
<tr>
<th>Analytic Process and Purpose</th>
<th>Data Sources</th>
</tr>
</thead>
</table>
| Open coding—incidents relating to engaging with student ideas or thinking | Math methods online discussion about small group observations  
Seminar blog entries  
Lesson plans  
Reflections of lessons taught for methods classes  
Final reflective essays for methods courses (about their three lessons taught in each course)  
Exit interviews with mentors  
University course observations  
Seminar child study reports  
Collaborative reflection logs  
Mentor feedback (Janice) |
| Contextual information | University course syllabi  
University course field notes  
Science autobiographies and content reports  
Math methods journal entries  
Seminar blog posts  
Seminar school context report  
Collaborative reflection logs |

**Coding**

Coding, as a result of the contemporaneous nature of data collection, was ongoing and iterative using NVivo (QSR International). During the data collection phase, codes were applied during a quick initial round of analysis and through a reflective memoing process. Memos were used as both reflective tools to garner insights into trends and patterns, but also provided suggestions as to how to code data.

Prior to starting, I developed a collection of initial *a priori* codes that were based upon the framework designed by Barnhart and van Es (2015) (see Table 5), in which I coded where, what, and how the primary participants attended to, interpreted, and
responded to student thinking as having low, moderate, or high sophistication. For example, an interaction that involved attending to a student’s thinking could involve pointing at a problem in front of the student or directing the student to provide an explanation, while answers could include how the teacher responded to a student’s answer or explanation. Interpretations were more difficult to identify as they are often invisible, but were addressed to some degree in the follow up interviews. Sophistication level had to do with how deeply the primary participant engaged the student in content. Low sophistication events were those that simply asked for a repeat of what had been provided to the student (e.g., memorized facts or restating something that was just said in class). High sophistication events were those that delved deeper into the meaning of content or thought process of a student, such as when a participant asked a student to explain their choice or thought process. Additional codes were designed to identify the nature of teacher noticing (student initiated, teacher initiated, mentor initiated, behavioral display, etc.; see codebook in Appendix C). For example, when a resident was called over to help a student, this was a “student initiated” query. A rapid initial coding of field notes occurred immediately following observation and prior to interviewing in order to highlight incidents to ask the preservice teacher about during their interviews. For example, during one observation, a primary participant asked a student to do a problem that involved solving an algebraic equation on the board. The resident then responded to an error the student made involving a negative sign by pointing out the error and giving positive feedback when the student fixed the sign that was indicated. I then followed up
with an interview question about this situation to ask them about why they chose this approach (to point out the error directly) and asked them if they could think of another way to approach this situation (e.g., ask the student to first check their work). This allowed me to assess the participant’s thought process around pedagogical choices, but also attend to their ability to interpret the student’s thought process by asking them why they thought the student had made that mistake and whether they thought the student understood their error and reason for the correction.
Table 5. Codes and Definitions Used to Describe Noticing Skills

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Noticing</strong></td>
<td>Tends to focus on behaviors and management. Students are either participating in their learning or not.</td>
<td>Tends to focus on accuracy of student responses. Measures of student participation hinge upon whether they are correct or not.</td>
<td>Looks deeper at how students think about material and the reasons behind their responses. Plans for or addresses student misconceptions. Student thinking is primary.</td>
</tr>
<tr>
<td><strong>Attending</strong></td>
<td>Teacher pays attention to behaviors (academic and non-academic). If they ask a question, it is factual and specific to the task at hand, whether social or academic.</td>
<td>Elicits student ideas that are explanatory in nature and not merely a simple yes/no/regurgitation (could be somewhat open ended but directly related to task at hand).</td>
<td>Asks specific questions to elicit student explanations or detailed responses. Questions are specifically about the content and tend to be open ended.</td>
</tr>
<tr>
<td><strong>Interpreting</strong></td>
<td>Resident decodes student idea and makes a judgement about what the student means in terms of accuracy.</td>
<td>Resident identifies the accuracy of a student’s response, but also can describe the meaning behind the response, but only in terms of being directly related to the current lesson goal.</td>
<td>Resident identifies a student misconception or makes a connection to a previous explanation a student gave. Looks for deeper meaning behind responses in terms of connecting beyond the current class purposes or goals.</td>
</tr>
<tr>
<td><strong>Responding</strong></td>
<td>Resident gives a yes or no type response to a student question or addresses a problem by providing the answer or giving directions that directly point at an answer.</td>
<td>Moves on to next part of class (per lesson plan), but references previous questions or addresses issues later.</td>
<td>Asks probing questions that ask student to explain more or go deeper and make connections OR Changes direction or probes in such a way to specifically address misconceptions or lack of depth of response.</td>
</tr>
</tbody>
</table>

\*a blanket term for when it was difficult to pinpoint specific patterns of attending, interpreting, and responding

Data were examined in an ongoing basis using a critical incident technique to identify the highest value types of events to explore further during interviews and data
triangulation. I defined critical incidents as moments when primary participants had the opportunity to obtain information about student thinking, whether they take advantage of that opportunity or not. Specific examples of these incidents that either exemplified the most common types of interactions or a specific interaction that stood out for being unusual were brought up during interviews and able to be coded further as to whether they aligned with particular levels of sophistication or type of noticing action. Codes for opportunities that could have been engaged in, but weren’t (i.e., opportunities that were “missed,” in my opinion) and focusing on activities other than student thinking about science were developed in an emergent fashion. Often primary participants referred to or responded to issues around classroom management, which resulted in “classroom management” as being a distinct code.

Participants were organized into categories based on their teaching beliefs and noticing practices following Phases 1 and 5 of the study. These were based upon the categories defined by Luft and Roehrig (2007; see Table 6) and Barnhart and van Es (2015), and is very similar to the categories used by Hawkins (2016). These categories align low/moderate/high noticing skills (attending, interpreting, and responding) with the beliefs of each primary participant around teaching and learning science. For example, a resident who tends to ask clarifying questions and selects curricula based upon teacher goals and not student needs would be classified as low noticing (medium ability to attend due to a focus on content, but low responsiveness that also indicates an interpretation is merely based upon accuracy of
answers) and *Instructive* (teacher is “all knowing sage” who determines what science facts need to be learned and how to offer these ideas to students). These categories were also modified to fit mathematics classes, as two primary participants were mainly engaged in teaching mathematics throughout the study period.

Table 6. Teaching Belief and Orientation Categories

<table>
<thead>
<tr>
<th>Orientation</th>
<th>Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Teacher Centered. Teacher provides facts, students soak up facts. Science/math are sets of facts and/or rules.</td>
</tr>
<tr>
<td>Instructive</td>
<td>Teacher Centered. Teacher provides experiences for students. Science and math are mainly sets of rules or facts, but possibly a bit more expansive and considers that they are a system of processes and therefore fairly fixed.</td>
</tr>
<tr>
<td>Transitional</td>
<td>Relationships are in focus. Teacher guides students to either know more than facts (can explain in own words), but also to some extent the meaning of material (knowledge) or have positive feelings toward learning the material (affect). Math and science are thought processes, but not very dynamic.</td>
</tr>
<tr>
<td>(Knowledge- or Affect-based)</td>
<td></td>
</tr>
<tr>
<td>Responsive</td>
<td>Student Centered. Learning is collaborative, where students give and get feedback in order to learn. Math and science are dynamic and reflect social structures.</td>
</tr>
<tr>
<td>Reform-based</td>
<td>Student Centered. Teacher is a guide who provides the appropriate experiences and resources students need in the moment to fully learn material. Math and science are dynamic and reflect social structures.</td>
</tr>
</tbody>
</table>

Note: These definitions are based on the categories created by Luft and Roehrig (2007)
Cross-case Comparisons

I performed data analysis in an ongoing fashion, as described above, but then once all data was collected and main codes identified, I examined each case on its own and then in comparison to the others individually, and the quintain as a whole in order to perform cross-case comparisons (Stake, 2006). The compositional structure of this comparison reflects the nature of the study, in this case an exploratory design that is “linear-analytic” (Yin, 2014, p. 254). For each cross-case comparison, each case was examined with each other case and common themes and trends were identified and pulled out as assertions about the common (or uncommon) experiences of preservice middle grades teachers in this university-based residency program. The results are presented as a multiple case report similar to that described by Yin (2014), wherein the final analysis and report focuses heavily on the cross-case comparisons, but the individual cases are reported separately. The structure of Chapters 4 and 5 are written in response to my research questions. Chapter 4 discusses the general status of the primary participants and their contexts, then discusses the general themes I identified as I coded my data. Chapter 5 responds to research questions two and three, which are more concerned with development over time. Therefore, Chapter 5 contains multiple case studies and a cross case comparison. Chapter 6 brings together the assertions I drew from my research and implications these have for teacher education and future research in this field.
Validity and Reliability

In terms of validity and reliability, in qualitative research I agree with Creswell (2014) when he summarizes what he calls “validation strategies” (p. 250). These strategies are meant to minimize researcher bias while maximizing dependability of the data and results. To this end, I have engaged several of Creswell’s suggested techniques, such as “prolonged engagement and persistent observation” (p. 250), triangulation, clarifying my bias as a researcher, member checking, and use of “rich, thick description” (p. 252). This is in addition to testing my protocols in a different program and set of contexts during a pilot semester (Spring semester) and modifying them as a result of my initial analysis. Furthermore, the entrance and exit interviews were based on a previously published protocol (Luft and Roehrig, 2007), also validated in various populations. Below I will describe the different ways my work can be regarded as valid and dependable.

Ethical Considerations

Creswell (2014) describes “ethical validation” (p. 248) as potentially important to consider in qualitative research. My concerns as a qualitative researcher reporting on the lived experiences of my subjects include being aware of representing, rather than speaking for, my participants. To this end, it is important that I consider my participants when not only collecting data, but throughout the analysis. Below I describe some of the ways I considered my participants and attempted to be as ethically valid as possible.
This study had limited ethical implications in that there were limited risks of physical and emotional harm, and the study appeared to be helpful to participants, as the process of interviewing was often viewed as a useful tool for self-reflection. Additionally, harms were minimized by the fact that subjects had the opportunity to opt out at any time without penalty.

An important feature of case study research is developing a rapport with my subjects such that they trust and are open with me. My observations needed to be unobtrusive and reflect the authentic nature of the classroom experience. One way I built this rapport was through my personal connection with their teacher education program and instructors. I had the fortune to be introduced to prospective participants through their program during the summer in the capacity of being an employee (I left the program’s employ a month before starting recruitment) and summer session workshop instructor. Residents were willing to see my work as being part of the background noise of being in a teacher education program, which already involves a lot of observation and guided reflection by multiple members of the programs’ staff and faculty.

Teaching, even for veteran educators, involves a revolving door of observers, and therefore my work is another opportunity for preservice teachers to become comfortable with having additional adults present in their classroom. It was also important that I made it clear that my observations, notes, and conclusions were non-evaluative and did not reflect any personal judgement about the abilities or personal attributes of the preservice teachers. Participants were repeatedly reminded of their right to halt participation or
select not to participate in any part of the process without consequence. For example, I checked in regularly with participants and reminded them that I was willing to step out if they ever felt my presence was a problem. I also carefully respected their privacy and did not pass along information about their progress to program staff, thus making it clear that my work was indeed separate from the program.

Through careful cultivation of my relationships and interactions with all participants, my role became a deeply ingrained observer-as-participant (Kawulich, 2005; discussed more in the next section). I developed a working relationship with the primary participants’ coach that allowed us to work side by side to ask questions during the follow-up sessions for observations. This also had the added benefit of reducing the amount of time needed to interact with the residents and their mentors, thus showing respect for their time.

After completing my analyses, I reached out to my primary participants with my summaries of their experiences (at least the general experiences) and a list of my assertions. I asked them for their feedback and to make expressly make certain that my conclusions were in line with how they perceived their own experiences. All but one of my participants responded. All five respondents expressed agreement, although one had an additional personal observation they felt was missing, which I address in my conclusion as it opens an alternative perspective on noticing that needs to be considered in future research.
Finally, to address the privacy, safety, and security concerns of participants, the school districts, and [MA] University, I attended to several procedures. First, to protect personal information, data was kept on a secure server and no personally identifiable data was gathered other than name and school email address of each participant. A single person (myself) encoded names of participants and settings, and the code was kept separate from the data. Second, all procedures underwent review by the Institutional Review Board (IRB) at my university and research review by the district in which I performed my research (both completed a final review of revisions in September). Additionally, I underwent the clearance processes as defined by my university, the state where I work, and the schools in which I performed this research. Copies of all approvals, IRB materials and clearances are archived in Appendix A.

Trustworthiness

Validation strategies in qualitative research include member-checking, the use of thick description, and the rapport developed between the researcher and participants (Creswell, 2013). The use of multiple data sources aided in the development of thick description in my results and conclusions, and provided opportunities to triangulate my findings (see below). Additionally, participants had an opportunity to read a summary of my findings and the introductions of their case studies as written for Chapter 4. I appreciate their thoughtful input and willingness to take time out of their busy days to assist me.
I feel I developed a strong rapport with all participants as evidenced by several events. First, mentors seemed genuinely sad to hear I was done and invited me to return later in the year to observe how things are going to satisfy both my own curiosity and because they felt I always asked thought provoking questions. Second, residents expressed they would miss talking to me. One accidentally missed his exit interview and said he had been looking forward to it all week, so was sad to put it off longer. Several participants and non-participants said they couldn’t imagine classes in the next semester without me, with a couple even inviting me to return for seminar. Finally, even some of course instructors remarked that they had almost forgotten I was collecting data and had considered me, in some ways, part of the class. Although not a true participant, my role did successfully become what Kawulich (2005) described the observer-as-participant. I was mainly there to collect data, but through my questioning, periodic direct involvement (e.g., I ended up being the substitute instructor for science methods for two days), and constant unobtrusive presence, the lines between researcher and colleague began to blur. Eventually it became difficult to precisely describe the boundaries of my role in my participants’ experiences.

As mentioned, triangulation of data is an important aspect of research validation (Creswell, 2013). Triangulation occurs when one uses multiple forms of data from multiple sources to substantiate the researcher’s assertions. I used observations and interviews I performed, plus the various artifacts I collected, to provide support for my claims. For example, in order to explain why a primary participant appeared to notice
more student thinking about how the inquiry process informs scientific information towards the end of the semester, I examined the feedback they received from their mentors and coach, as well as the information they learned during the methods course, particularly in terms of the way the methods instructor frames inquiry’s role in scientific knowledge construction.

**Potential Researcher Bias**

As the sole researcher responsible for all observations, interviews, coding, and analysis, it was especially important that I identify and reflect upon my own biases about teaching and teacher education. My experiences as a middle grades science teacher and teacher mentor give me the professional perspective necessary to identify critical incidents of student-teacher interactions around student understanding, but also may influence the amount of weight I ascribe to different types of interactions. For example, in my own classrooms, I tend to ignore certain physical behaviors, such as tapping of pens or shifting in seats, and so I may not make note of when participants are attending to these instead of, or as a substitute for, making sense of student thinking. Alternatively, it is possible I systematically paid more attention to when preservice teachers notice behaviors because it is something I, personally, feel is a waste of time. Therefore, I found it easier to notice their attention to behavior than when they paid attention to student thinking. Additionally, attending to student thinking comes naturally to me, therefore I have a tendency to prioritize this over all other observations. I had to make a concerted effort to take careful notes and maintain an open mind. It was important that I gathered as
much varied evidence as possible to support and attempt to refute my assertions and conclusions, and hold my findings up against my theory as well as alternate explanations for my observations. One major alternative to noticing student thinking is that novice teachers have a tendency to focus on procedural and behavioral issues (management) rather than student ideas. This potentially impacted the interpretations I have made about the noticing skills of the participants (i.e., I might have assumed they never notice student thinking because I mostly observed their responses to behaviors). Additionally, it is possible I missed making note of the missed opportunities participants could be taking to notice student thinking because I was distracted by writing a note about a behavior management issue. Therefore, it was important to me that I use time stamps and parallel notation tools to note these events. I did my best to be true to the context and participant I was observing.

Limitations

All research has limitations, especially when performed by a single individual under a limited period of time. The biggest limitation to this study is the use of classroom observations without video support. Due to the dynamic nature of the classroom and the limitations of my own observation, it was not possible to identify all possible opportunities for teacher noticing; however, it was sufficient for giving an overview of the types of noticing and the cues initiating said noticing to occur, such as mentor intervention, student behaviors (e.g., arm waving, calling out answers, asking questions, creating distractions, etc.), or preservice teacher’s methods for eliciting student ideas. The
noticing framework stems from early work using video footage of classrooms and therefore video has remained a major tool in noticing research (M. G. Sherin, Russ, & Colestock, 2011b). As M. G. Sherin et al. note, video usage has certain affordances in terms of eliciting recall about specific events, but due to the nature of the school district’s concerns for student and teacher privacy, it is extremely difficult to gain such access to the classrooms I wished to observe. Therefore, my conclusions are dependent upon my own expertise in the classroom setting and ability to make note of useful and relevant incidents. One thing I did to try to gauge the development of teacher noticing was to use video footage of other teachers’ classrooms to elicit responses about noticing from participants. However, this, too, has limitations to the validity of assumptions to be drawn, because what teachers notice in unfamiliar classrooms may be significantly different from what they notice in their own setting where they know the students and routines. It was my hope that by observing the classroom and then interviewing the subjects soon after, in concert with observing post-lesson discussions with mentors and coach, I could get a clearer picture of the types of classroom actions that draw the preservice teacher’s attention and their thought process more generally. It does not necessarily always explain what they are thinking in the moment, but should illuminate their values and the schema they may be using to make decisions.

One of the major limitations associated with case study is in identifying appropriate cases and numbers of cases. On the one hand, I wanted to have rich data that explores multiple contexts experienced by preservice teachers. On the other I wanted to
be careful not to weaken my analysis, as Creswell (2013) warns, and lose sight of my purpose. My ability to build a rapport with my participants was a major contributing factor of my ability to access all the data I needed to draw a credible and valid conclusion. Additionally, as I made assertions based on my observations, I needed to keep in mind the level of generalizability one draws from a small sample and limited range of contexts. Although I attempted to draw my sample from participants from various locations, the variation represented ultimately affects the types of conclusions I could draw.

Summary

The purpose of this study design was to examine the in-the-moment noticing skills (professional noticing of student ideas) of preservice teachers engaged in methods courses and ongoing residency-based field experiences from the start of the year to midway through their year-long teaching program. The methodology is a multiple case study with analysis based on themes identified in the mathematics education literature on professional noticing and adapted to suit science classroom activities. Given the affordances of using observation and interviews, this study serves to both develop a clearer framework for evaluating science teacher noticing in vivo, but also provides insight into the way preservice teachers integrate information from their university courses and field experiences to develop professional teacher skills.
CHAPTER 4
GENERAL NOTICING PATTERNS

Introduction

This chapter is devoted to establishing the contexts of the larger quintain, starting with descriptions of the individual cases and then moving on to a cross case analysis that addresses my first research question, “What professional noticing practices do preservice science teachers (PSTs) engage in when interacting with student ideas and work in science?” Chapter 5 will address the individual cases in more detail as specifically pertains to their experiences around noticing to answer research question 2. Chapter 5 will end with a final cross case analysis to compare the math PSTs and science PSTs for my third research question.

Introducing the Cases

The ability to not only actively elicit student ideas, but also analyze them for meaning and then use this meaning to determine which teaching strategy to follow up with, is complicated and built upon the foundation of the teacher’s beliefs (Schoenfeld, 2011). Therefore, it is important to first identify, as best as we can, the teaching orientations of our preservice teachers at the start of the study (Hawkins, 2016).

During Phase 1, I interviewed my primary participants to gain insight into their initial teaching beliefs and orientations, along with a short video-based assessment of their noticing tendencies. These findings, combined with their coach’s initial observation that occurred before my interview, show that early on primary participants had variable,
but all relatively novice, views of teaching and noticing skills. During this period, they were mainly thinking about relationship building with students and classroom management. If they discussed content, it was always mostly about the accuracy of student ideas. I discuss below the specific orientations for each resident, however as will become evident, the general consensus of the residents is that teachers are guides for students, but the goal is accurate responses to factual questions stated in students’ own words. What was often missing was the deeper meaning or application of content in new situations.

Phase 1 also sets up the contexts for each resident with whom I worked. The next six subsections will describe each resident, their mentor, and the resident’s initial orientation (see Table 6 for definitions) and noticing abilities (see
Table 5 for definitions). The teaching beliefs/orientations of each primary participant are presented in Table 7, which shows the number of times each PST was ranked at a certain orientation level for a particular attribute (used in the TBI; these include beliefs about: 1) how to maximize student learning, 2) the role of the teacher, 3) making decisions about content, 4) when to move on, 5) how students learn best, 6) when learning is occurring in the classroom, and 7) what it means for a student to understand content) and their median orientation at that point in time (Phase 1, in blue; Phase 5, in red). Table 7 also shows whether each resident changed their overall orientation by the end of the semester and by how much (“Change in Median”). A summary of each resident’s orientation and noticing skill level at the start of the study is presented in Table 8. Each resident’s responses to the TBI protocol’s questions (Appendix B), were evaluated using Luft and Roehrig’s (2007) rubrics. The overall picture painted of each resident cannot be defined by a single perspective, but rather each is a composite based on the categorial ranking system used. Some residents had very similar statements about their ideal goals for teaching, but often would provide examples or fixate on particular topics that implied they were divided between multiple belief systems. The range of belief categories may be along a continuum, however, the way beliefs have been shown to change or develop implies that multiple factors can impact teaching orientations, how they develop, and how teachers practice relates to their beliefs (e.g., Luft, 2001; Luft & Roehrig, 2004; Roehrig & Luft, 2004). For this study, the utility of tracking beliefs is primarily as a way to help interpret and track the decisions made by the PSTs throughout.

### Table 7. Teaching Belief Scores Based on TBI

<table>
<thead>
<tr>
<th></th>
<th>Traditional</th>
<th>Instructive</th>
<th>Transitional</th>
<th>Responsive</th>
<th>Reform Based</th>
<th>Median</th>
<th>Change in Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luke</td>
<td>3 135</td>
<td>1257 2467</td>
<td>46</td>
<td>C C</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Janice | 12356 4 | 7 3^7 | 123^a | 4 56 | A C | 2
Anthony | 2 12^b3 | 34 47 | 16 3 | 57 5 | C B | -1
Jason | 4 4 | 126^a 123 | 6^e 567 | 35 | C/D C/D | 0
Estelle | 34 4 | 2 2357 | 1 1 | 56 6 | 7 | C B | -1
Vale | 12 | 123 4^a | 45^67 34^567 | E E | 0

Note. Numbers indicate question from TBI (Appendix B)
Blue questions are Phase 1, Red questions are Phase 5
Yellow indicates no change, green indicates positive change, orange indicates negative change in orientation
^a borderline response (may have a high ideal, but provides qualifiers or is tentative)
^b also acknowledges value in being a role model (leaning toward transitional)
Table 8. Primary Participant Noticing and Teacher Orientations During Phase 1

<table>
<thead>
<tr>
<th>Primary Participant</th>
<th>Teaching Orientation</th>
<th>Typical Noticing Ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luke</td>
<td>Transitional</td>
<td>Moderate Noticing</td>
</tr>
<tr>
<td>Janice</td>
<td>Traditional</td>
<td>Moderate Noticing</td>
</tr>
<tr>
<td>Anthony</td>
<td>Instructive, with a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tendency toward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transitional</td>
<td>Low Noticing</td>
</tr>
<tr>
<td>Jason</td>
<td>Transitional with a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>small tendency toward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Responsive</td>
<td>Low to Moderate Noticing</td>
</tr>
<tr>
<td>Estelle</td>
<td>Instructive, with a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>strong tendency toward</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transitional</td>
<td>Moderate Noticing</td>
</tr>
<tr>
<td>Vale</td>
<td>Responsive</td>
<td>Moderate to High Noticing</td>
</tr>
</tbody>
</table>

Luke

Context. The first resident, Luke, and his mentor, Ms. Childs, taught at MASD East (MASDE). Ms. Childs has approximately two decades of teaching experience in the
city, including middle grades math and science and high school algebra and chemistry. Luke’s and Ms. Childs’ schedule included two seventh grade and two eighth grade science classes, plus a mixed grade advisory period. Their student population included a range of abilities from those who are below grade level to students in honors algebra. Broadly speaking, the students were seated at a mixture of tables and individual seats in a room held together in a barely contained chaos. Ms. Childs admitted classroom management wasn’t her forte, however, it was clear she had a loving relationship with her students and they responded to her accordingly. Mentor and resident began the year with a strong relationship and already saw eye to eye on many topics, especially around wanting to integrate Luke in lesson planning early on through having him establish a curriculum plan during the preparatory period for the new academic year. Unfortunately, the curriculum Luke’s original plan was based on was swapped out by the district once the school year started, which caused some additional chaos in MASD East science classes generally. Overall, Luke and Ms. Childs had an easy relationship that allowed for frequent and open communication about students, learning, and life.

*Initial teaching orientation.* Luke showed early interest in student-centered instruction that uses formative assessment to determine how much students know and how to adjust his teaching accordingly. For example, he asked me at one point during the first month of the semester if I could sometime talk more about culturally responsive teaching practices, cooperative learning, standards-based grading, and mastery learning, each of which were topics that were briefly discussed during a workshop I ran while I
was still working for the residency program. As seen below, Luke’s mental image of teaching already included using student-centered lessons that rely heavily on peer-to-peer discourse, with the teacher’s role as being one where they pay attention primarily to student engagement and accuracy in order to make decisions about instruction:

I guess a teacher has to get good at those in the moment formative assessments, gauging the students’ progress along the way and if we’re shooting for an 80% mastery or learning of whatever that content is at that point, you can move on once you’ve been able to assess that. If things are really not being learned by the students, if this lesson or this approach is not effective, I think you’ll be able to see that because the students are really disengaged. At that point it might be time to try a new approach or move on to something else and circle back... I guess I’m imagining some group activity where students are participating in it. They’re talking, but it’s on topic, there might be some excitement, movement. I would be circulating and asking questions to make sure that they’re headed in the right direction to guide their learning, to make sure they’re not picking up or interpreting things completely wrong. Everything is open to interpretation, but we want it to be headed in the right way. (Luke, Intake Interview, 9/14)

This quote hints at Luke’s views on learning, as well. He appears to have entered the program with a sophisticated view about learning and the nature of science, wherein scientific knowledge is not absolute, but instead dynamic, constantly renegotiated as new information is uncovered (McComas, 1996, provides a short review of common myths about the nature of science). Luke also connects engagement with learning (“talking, but it’s on topic”), which he ties directly to the teacher’s choice of pedagogy (“asking questions” and “group activity”); however, his description of what he is looking for is focused primarily on accuracy rather than depth of understanding. Given Luke’s mental image of teaching involves active engagement of students, but limits his focus to accuracy, his orientation could be seen as merely Instructive (Table 7 and
Table 8; Luft & Roehrig, 2007). However, he sees his role as a teacher to be as “a
guide to help students understand new skills and learn how they can incorporate them
into their lives, use them in their lives to benefit them inside and outside of the
classroom” (Luke, Intake Interview, 9/14). I categorize his beliefs about teaching and
learning as Transitional with a focus on knowledge (Table 7; Luft & Roehrig, 2007).

When asked what student understanding looks like, Luke described his ultimate
goal as using various types of assessment to see if students are able to effectively explain
concepts in their own words, where effective means being able to accurately explain a
concept to someone else, be it the teacher or a peer:

I would like a student to be able to explain to me what [a phenomenon] is. In clear and complete thoughts, explain it to another student, to be able to
work with the student who might be struggling and help them along, or in
terms of formal assessments you could use a project, some sort of wrap
around or cumulative project. (Luke, Intake Interview, 9/14)

His mentioning different possibilities of summative assessments suggests that he
values measuring student understanding, however, he is open to doing more than giving a
test where students may repeat back teacher explanations. Based on my experience
working with novice teachers, this openness to alternative forms of assessment is special,
and implies he has a broader appreciation for what it means to learn material. However,
his definition of what it means to really understand something is still based in the idea of
accuracy rather than encompassing the broader notion of understanding connections
between content or reasoning behind concepts.
**Initial noticing ability.** During the Intake Interview, I also showed Luke a video of a classroom interaction involving a teacher and group of five students. Luke’s initial reactions to the video miss some details that could have been noticed (such as only one student doing most of the talking), had they been important to him and within his ability to notice. When pressed to comment on the students and teacher, his statements were focused on the content. His initial reaction was to decipher the content for meaning, “It took me a little while to catch on to what they were actually doing, trying to observe and what they were doing in the lab.” When asked about the students, he specifically made note of the “linear” way the students came to an explanation of their phenomenon, with the teacher “leading them along.” Upon being asked to talk about the teacher, he described the meaning behind her questions as well as some of the types of questions posed:

Well, the teacher was just trying to lead them along in that process to help them I guess consolidate their observations into a greater learning of how [it worked]. At the end she talked about how they might modify that experiment to observe the results that they had expected. She probably started off by asking them what they expected to see and then what did you see and did that match. (Luke, Intake Interview, 9/14)

As van Es and Sherin (2008) illustrate in their work on using video clubs to enhance teacher noticing, initially participants in these clubs focus on what the teacher is doing (pedagogy) and then with instruction from the authors and practice, they shift their focus onto student thinking. Here, Luke shows he is doing more than just paying attention to the teacher, however, he doesn’t attend to the meaning of what the students are saying, simply what they said. Ignoring meaning behind thinking and looking for responses as if
they check off a box in his mind is a hallmark of a Transitional Teacher. In terms of noticing, his skill level was of moderate sophistication in that he seemed to be looking for (correct) answers rather than the meaning of the explanations given, but had an appreciation for the pedagogical choices of the teacher in leading the students’ responses. Luke noticed that the teacher used a “what if” type question to push the students to extend their thinking, which he also tied back to the possible early questioning of the teacher who was guiding the students to work their way through the logic of the activity.

Luke also showed an impressive early ability to question students, as observed by his coach:

While instruction was being delivered, Luke circulated the classroom and interacted with students. While students completed written work, Luke identified students needing assistance and offered support through questioning and guidance. Luke was observed asking a struggling student, “Do you know what this word means? Explain it to me. Let’s expand that thinking” and he proceeded to rephrase the question the student was struggling to answer. (Coach Nan, Formal Observation, 9/13)

During this observation, Luke effectively questioned a student in such a way as to encourage the student to use their own words to explain their work. His responsiveness was focused on accuracy, though. His ability to identify students who needed his help was notable, as he made these determinations on the fly, based on the work he saw in front of him.

These pieces of evidence, in addition to the interest Luke expressed in creating safe and cooperative learning environments during the summer session, show that he began the year with a moderately sophisticated mental framework about teaching that he
was starting to act upon, and was open to learning more. He had potential to focus on his own questioning consistently, making him a good candidate for learning to notice student thinking, particularly through asking responsive questions that probe student understanding.

Janice

Context. Located at the same school as Luke, Janice was placed in an eighth grade math classroom with her mentor, Ms. Gilmore, at MASDE. Their classes included one honors algebra I class and three general education eighth grade math classes, plus the requisite mixed grade advisory. Ms. Gilmore has been teaching for five years and has a natural order and organization to her teaching. She admits she is not so great at planning ahead, but always has a strong image in her head of what she will be teaching before leading class. During class she is quick to pick up on student misconceptions and is a master at noticing, often picking up on adjustments she should make in class before even I realized what was happening. Throughout the semester Ms. Gilmore tried several ways to communicate with Janice about her practice, to varying degrees of success. Janice and her mentor quickly built a rapport that made Janice comfortable with assisting and working with students from day one. It is worth noting that I was particularly intrigued by the standards-based feedback system posted on the wall. Ranging from minimal to thorough, each poster defines and provides clear guidance for improvement with an emphasis on work ethic and practice, indicating that Ms. Gilmore acknowledges the roles of effort and practice in becoming a strong mathematics student.
Initial teaching orientation. Janice was happy to work one-on-one with students, which is unsurprising given her many years of experience as a tutor. But, as was noted in her second Collaborative Reflection Log (9/24), she would focus her attention on one student or one small group of students for the entire period. Her coach also noted that Janice comfortably pointed out behaviors and kept students on task with limited focus on deep mathematical thinking:

[Janice] gave specific feedback regarding students’ math work, which communicates to students that she is invested in what they are doing. As she begins to instruct students more directly, Janice is encouraged to consider asking students questions about their work and/or thought process when she observes students struggling or making errors in their skills. Guiding students through questioning not only holds them accountable for their work, but also facilitates a conversation about the thinking involved in math, which leads to a deeper understanding. (Coach Nan, Formal Observation, 9/13)

This tendency to focus on algorithmic thinking encapsulates much of Janice’s early teaching orientation. For her, the focus of a teacher is to manage classroom behaviors and get students doing work accurately:

If they can do the problem, well, for math, if I see they are dividing their problem out, and they’re following the steps, and I can see that they’re getting the right answers, I can tell that they understand how to do what we’re asking them to do. (Janice, Intake Interview, 9/14)

Even after reading about and discussing mathematical thinking in math methods (the class read Newton & Sword, 2018) and scientific thinking in science methods, Janice continued to only look at student work only as much as it could tell her if students are doing the work correctly. She conflated curiosity about learning something with the act of exploring a problem to learn using curiosity as a driver. In fact, she connected the reading
to something that explicitly counters what the reading suggests by saying she recently reduced the expectation that students should be intrinsically motivated to understand mathematics deeply (i.e., have curiosity) in her class and instead pushes an extrinsic motivator to get them to just do the algorithms provided.

This week instead of telling them so you can solve more complex problems later I said in case you get the wrong answer we can still give partial credit for the work completed if it shows that you know what you are doing. (Janice, Math Journal #1, 9/7)

I saw this same surface level way of looking at mathematics in how she described her experiences with science. She admitted in her science autobiography (9/13) that she was good at chemistry and physics, likely in part due to her being good at mathematics. She opted to focus on mathematics, though, because she enjoyed doing it, even when it became more challenging in college.

Tutoring for many years had honed Janice’s ability to assess student understanding in terms of accuracy and ability to apply their learning mathematics to new situations. The ability to extend knowledge to new situations was what she considered the apex of understanding:

I think they could fully understand when you give them a problem that’s not exactly what we’ve been studying. Give them a word problem and they have to find the equation themselves. I think by doing that because we’re expressly giving them the work, we’re not giving them the problem to solve, we’re making them figure out the equation for themselves and then solve. (Janice, Intake Interview, 9/14)

Janice’s discussion of learning math (and science) extends only so far as to accurately apply to a new situation. She doesn’t consider the meaning behind the material
and how students can access that meaning. Even in terms of her own memories of science, including as a temporary double major in mathematics and physics, her recollections of science are focused on material that is something one memorizes or pieces together to solve, but not understand:

There were a few lessons that I remember well to this day such as Punnett Squares, species classification, and the life cycle. With the Punnett Squares, I remember setting up the square and entering the genotypes to find the predicted phenotypes. It was during this demonstration that I realized that for me to have my blue eyes, my mother, since she has brown eyes herself, must have the recessive gene for blue eyes. I also remember having fun figuring out which classifications an organism was placed in going down the list from kingdom to species. I thought of it as a puzzle to solve, I love solving puzzles. (Janice, Science Autobiography, 9/13)

I find it particularly telling that she ended this thought with connecting the material to puzzles, as puzzles are things we piece together but rarely have any deeper meaning than the picture formed in the end. Even many logic puzzles are often solved using a set of algorithms, thus not requiring much understanding of how the logic works, but instead how to simply do the problem at hand. This unsophisticated perspective toward learning mathematics and science, along with her inclination to consider advanced skills to be merely when one can solve a new situation, suggest she began the year with a fairly Traditional teaching orientation.

*Initial noticing ability.* Because Janice is focused on accuracy of responses, her noticing skills were moderate at best. She had moved beyond merely focusing on student behaviors, but was looking for whether students were using the correct algorithms
accurately. Her definition of what it means to be moderately successful implies a limited view of what true understanding means:

[When I say] ‘medium skilled’ [I mean] that they understand the basics of what integers are and how they work, but still need help to apply them in different situations, such as the real life word problems on that worksheet. My three students were able to figure out which numbers should be negative and which should be positive in their expressions, but when it came to how to combine them to get the correct answer they were a little lost. I had to ask guiding questions for them to figure it out. (Janice, response to query during Small Group Observation Online Discussion for Math, 9/24)

Here she points out that being able to use an algorithm is sufficient for being moderately successful, but true understanding (highly skilled) includes also being able to apply the material accurately to new situations. The focus on skills rather than meaning is telling, and suggests at this stage of the program Janice was still unaware of any other way of knowing material. This perspective was also clear when she was asked to comment on the video during the Intake Interview. She briefly commented on which students were involved in the discussion and whether or not they seemed to know the material, while her interpretation of what the teacher was doing focused on how she elicited specific information that she was then using to gauge the accuracy of their knowledge:

It looked like there was a group presentation. I think only one girl was actually answering all the questions and they weren’t all chipping in. Either they didn’t all really understand what was going on or they just were letting her give all the explanations… The student seemed to really understand what was going on and [was] able to explain things clearly and precisely… [The teacher] was asking guiding questions, not giving the answer. She wanted to know what the student knew. (Janice, Intake Interview, 9/14)

Although it is difficult to judge precisely what was meant here by “know what the student knew,” given her other observations in classrooms, it would appear her perspective of
what teachers do is limited to focusing on intake of information and having students be able to repeat back this information accurately and appropriately.

Anthony

Context. The third primary participant and secondary participant dyad at MASDE was Anthony and his mentor, Mrs. Hartman. Together they taught four periods of sixth grade general education mathematics and one mixed grade advisory period. Mrs. Hartman is a thoughtful and authoritative presence, where her classroom is tidy, well organized, and everything on the walls was obviously chosen and designed with care, with a clear purpose in mind developed over her decade of teaching. Mrs. Hartman is caring and values being clear and precise in one’s language, which became a major discussion point over the semester for Anthony. Although their relationship was not an easy one due to different communication styles and ways of approaching the world, both showed respect for one another through their continued collaboration. They worked on their communication all semester in order to align their frames of reference and help Anthony learn how to effectively and consistently focus on the main learning goals of a lesson, and act upon the teaching and learning practices and ideas he was actively thinking about.

Initial teaching orientation. When you observe Anthony in his university courses or during interviews, you notice that he is unafraid to admit when he doesn’t know or understand something. He listens carefully and asks questions. His tentativeness to answer questions until he fully understands what is being asked of him carries over into
his classroom behaviors and beliefs. During the first observation, his coach noted that he “[was] very aware and reflective of his progress and communicated his areas of confidence as well as his areas of perceived improvement” (Coach Nan, Formal Observation, 9/13). As his Formal Coach Observation and Collaborative Reflection Log suggest, during these early weeks of the program, Anthony was focused on getting to know students and building relationships. His relationship to students is an underlying theme for Anthony. However, he is wary because he is aware of the challenges of being a Black male educator. He knows Black male educators are often relegated to the role of disciplinarian, which he does not see in himself. He is quiet and thoughtful, not loud and confrontational. Regardless, one of his major reasons for becoming an educator is to be a role model for his students:

[It] is not my main objective to only help the students of color. One of my motivations to teach is to let my students know I value them as people. And I believe that they all have the ability to learn. I want the students that step into my classroom to know that they have entered a safe place where they are free to be themselves. One of my pet peeves as student, was discovering teachers who were not genuine. For instance, if a teacher told the entire class to stop bullying a LGBT child, but in smaller group settings that same teacher threw shade at the same child. I hope to avoid situations like that because I genuinely care for the well-being of all my students as do most but not all teachers. (Anthony, Seminar Blog Entry #2, 9/21)

This desire to be a role model translates into his classroom presence in the form of learning student names, taking roll, and walking around the room to check in with students one-on-one. This led to his coach suggesting he start shifting his attention toward content understanding:
[Anthony] circulated through the classroom and checked on students as they worked. Students were given a problem to complete as class began, and [Anthony] looked at individual students’ work and ensured students were completing the problem as directed. I encourage him to consider this as a possible opportunity to build rapport and establish himself as a teacher in the classroom. Through asking students questions about their work and/or thought process when solving math problems, students are guided towards a deeper understanding. Additionally, this will build students’ trust and they will feel more comfortable approaching either of their two teachers with math related questions or difficulties. (Coach Nana, Formal Observation, 9/13)

Reading between the lines, it appears that if Anthony was checking for anything besides student behaviors, it was for accuracy and not understanding. Interestingly, this is almost in direct opposition to what he said about teaching and learning the next day, which indicates a delicate balance between his early goals and experiences, while possibly reflecting the fact that he was listening when his coach was giving this suggestion. Given the timing of this feedback and his Intake Interview, it is difficult to fully disentangle the impact of one on the other; however, it is also probably safe to say that it takes more than a day to change how someone might consistently respond to questions about their teaching orientations.

During his Intake Interview on September 14th, it was striking how much what Anthony had to say about teaching and learning has to do with relationships as well as being a responsive educator in terms of student knowledge. Here you can see the aforementioned tension, where he acknowledges the primary function of a teacher is to teach, however, what and how you teach needs to be responsive to the student.

My role as a teacher is to understand the content that you’re expected to learn in my grade and then how that relates also to the grades above you,
and how do I best see where you’re at now, and no matter where you’re at now, try to get you to understand more or to grow more wherever you’re starting at. I think that’d be my role, is to challenge and to pursue that. I think sometimes just as a motivator, too. (Anthony, Intake Interview, 9/14)

Anthony continues this train of thought later, when he introduces the idea of “mini-assessments” to help students move toward the next phase of learning, where the teacher asks open-ended questions to gauge student understanding. Even so, his focus quickly shifts back to the feeling a teacher might get while assessing students:

It’s not necessarily even what you did, but it’s how you did it. If you can explain to me what you were thinking and how you got to where you are, I think I’ll have a better judge of if you understand or not… [You] ask some students, ‘What are the next steps?’ If they let you know what those next steps are, I feel like learning has occurred. There’s probably a little bit of… No, I don’t have this skill, but there’s probably a feel to the room. I don’t know how you say it – You can probably visually look and see when your students, not necessarily are confused, but when everyone is off task and everyone has a glazed eye look, then you probably need to change something up at that point….I can’t necessarily say that like, ‘You understand because you’re looking at me directly.’ I don’t believe that, but I do think if you take a general look at your room, you can get a vibe… You can get the vibe that no one’s paying attention right now, but to really know if someone is learning, you have to ask them a question. You have to have them provide a written or verbal feedback in one way or another. (Anthony, Intake Interview, 9/14)

This focus on affect is also evident earlier in the interview when he described his observations of the short video of the teacher interacting with a group of students. He noted that it took him a minute to figure out what the students were talking about and this lack of comfort resulted in him paying attention to how the teacher and students interacted. He noticed who was contributing and how they were speaking. He got the impression that the main student talking understood the material (even if he did not) and
he assumed, based on vocal cues, that the teacher was trying to guide the students toward a clearer explanation of their experiment.

I wasn’t even paying attention to language for quite a bit, but from the tone and the sound of it, I would say she’s asking questions and drawing more, it’s like you’re getting something and she’s trying to pour more information on the student. Not even in that time, there is times it seems like it’s kind of they definitely have the knowledge, I would imagine, but it’s more introductory, this is not the end final product part. It’s just more like, ‘I just want you to do some exploring and I want you to do something, how do you feel about things?’ So that’s what I feel the teacher, she’s just guiding, ‘How’d you guys do in this project or experiment?’ (Anthony, Intake Interview, 9/14)

It is interesting to me that he focuses so much on the ambience rather than substance of the lesson. This is also demonstrated in his reflections on observations he made in the math and science class rooms he would be teaching in for his methods courses. His comfort with the material likely influenced what he noticed, but he still spent a good deal of time thinking about how students interacted with the lesson rather than their understanding of the material. In science, he mainly noticed how students interacted with the lesson and their level of physical and emotional engagement.

During this part of the [science] lesson I noticed that the boys of the group kind of took over. [One girl in the group] was pretty outspoken that she wanted to hold the glass jar and attempt the challenge of separating the materials. She had to practically wrestle it out of [one boy’s] hand. I think the other girls were interested, but the boys did not offer to share and they [the girls?] did not ask. Basically, every child seemed engaged during the hands-on portion of the lesson even if they were not handling the actual object. (Anthony, Science Small Group Observation, 9/27)
In math, where his comfort with the content is greater, he mentions whether students were able to do the work, but he spends more time explaining whether they were comfortable doing the work, their motivation, and their behavior around the substitute.

Regarding the success rate, I was able to determine their success rate based on their progress through the worksheet. The worksheet was comprised of real word problems. I think the success rate of the children was hampered due to their limited knowledge of the non-math subject matter. For example, the children in my group had no experience with [the concepts of] B.C. and A.D. making it hard to comprehend the problem. Regarding the math of using negative numbers, I could tell the children were taught about the rules. Although, they were in the area of learning where they knew what to do but not quite why they were doing it.

In general, the students in my group where [sic] motivated to perform the worksheet. I considered a student motivated if they ask for, or accepted my help. Additionally, they needed to appear to listen to what I said. I was only able to get to three students during the period, but they all seemed motivated. They asked clarifying questions after I gave them instructions. Plus, took they time to write the instructions I gave them. (Anthony, Small Group Observation Online Discussion for Math, 9/24)

It is also noteworthy that in his responses to his peers discussing his comments about the students being unclear about the contexts of the problems (e.g., AD/BC, the idea of “par” in golfing, etc.), he admitted his own lack of understanding of one context (“par”) and unfamiliarity with an algorithm students kept saying (“keep, flip, change”). Perhaps this is why he focused so much on behaviors—he was keenly aware of his own lack of understanding of the material.

Regardless of the reason behind these specific instances of paying attention to affect and behavior, the fact that Anthony generally connects learning to relational understanding of his students places him between Instructive and Transitional categories.
of teaching belief, with a strong focus on the relationship between himself and his students (Luft and Roehrig, 2007). This also parallels his recollections of learning math and science in school. In his science autobiography, he mentioned that he lost interest in science because he had difficulty seeing how different concepts connected. As an adult, he realizes this was as much his responsibility as his teachers’, but it still has left a lasting impression on him.

I believe the difficulty of the subject and the lack of connections I made between the sciences is why I began to lose interest in the sciences. I do not recall being taught the big ideas that connect the sciences. I do not want to put all the onus on my teachers. I know with math I resisted learning the techniques that would have made my life easier. Perhaps, I did the same with science. For instance… I think I should know how to use the periodic table better. While it is true the periodic table conveys many specific facts, it is my understanding that it also conveys big ideas within chemistry. I never quite grasped how to use those major ideas to develop an intuition to answer basic chemistry questions… As a student, I focused more of my energy attempting to pass a class instead of trying to understand the principals [sic] the class was founded upon. I now realize my approach to passing a class started long before taking the weed out classes. It probably started when I was in middle school during algebra which was my first truly difficult class. Fortunately, I eventually passed those early college weed out courses. But they were the last real interaction I had with science. (Anthony, Science Autobiography, 9/13)

Anthony now appreciates some of the complexity of science, including that it is not just a bunch of random facts and rules. There is a pensiveness to Anthony’s autobiography, where it seems as though he now feels he missed out on something. To some extent, I think this is what motivates him to bring in contexts that students can relate to and why he is attuned to student body language. He realizes the importance of making material personally relevant and more than merely a set of facts to be memorized.
Depending on how much time I have, I like creating the worksheets using topics that the students are familiar with. This will eliminate issues of subject matter for the children. (Anthony, Small Group Observation Online Discussion for Math, 9/24)

Anthony is also aware of how difficult it can be to plan such targeted lessons, but in a way, he looks forward to the challenge. When reflecting on what it means to make work appropriately cognitively challenging according to the specific needs of the student (Lynch, Hunt, & Lewis, 2018), Anthony says he appreciates that he will have to think critically about the reasoning behind the work he is assigning and the specific needs of his students:

I may initially struggle to create productive struggle activities for the students in my classroom. I like that it requires of me, what I require from my students. Which means it is not something I can do automatically. Similarly, to how I want my students to think critically, differentiating will require me to think critically as well. Also coming up with differentiating activities requires the teacher to have abundant knowledge of their students. Honestly, it makes me feel slightly overwhelmed right now thinking about differentiating for over 125 children. But I imagine with time, I will discover ways to implement it in the classroom more efficiently. (Anthony, Math Journal #3, 9/28)

This spirit of curiosity and being open to trying new things is also something he values as a basic skill all students should learn. When discussing various mathematical habits students need to engage in and learn, he adds in that students need to learn some resilience in the face of challenging material. Even before learning about productive struggle, Anthony was thinking about what it looks like to learn math. In addition to “seeking and using structure,” “using language clearly and precisely,” and
“experimenting” in mathematics (Newton and Sword, 2018), Anthony adds that students also need to learn to persevere in the face of challenges.

I would like to add that students need the habit of perseverance. When you are experimenting, trying to approach it from several different ways is beneficial. Also, while performing experimentation, students need to know that wrong answers always come before the correct answer. Lastly, students need to learn to not get frustrated when they continuously arrive at the wrong answer. It is at this point they should consult with a friend or take a break from the work until after they have had good sleep. I mention these aspects of perseverance because math is difficult, but not beyond the scope for people to understand. It sometimes requires multiple views before one begins to understand it. Then it takes practice after that to become better at it. (Anthony, Math Journal #1, 9/7)

Perseverance could possibly be seen as a requirement for successful experimentation, but Anthony calls it out specifically with respect to learning mathematics because it is a personal characteristic that allows one to continue working despite initially finding the work to be confusing or challenging. He differentiated perseverance from experimentation by pointing out that even if one is not actively experimenting, they still need to practice and revisit the material before they can truly learn it. This is an important aspect of Anthony’s beliefs about teaching and learning.

Students can learn if they engage with the material, and teachers need to provide interesting and relevant material in order for students to want to engage with it.

Initial noticing ability. When asked to think about what he sees in a classroom setting, as mentioned above, Anthony focuses initially on behaviors over outcomes. He looks for clues that indicate whether students are participating and following along, with specific aptitudes being secondary to his interests. This is clear both when he described
his observation of students in a mathematics class (discussed above) and during his Intake Interview (9/14). Here Anthony paid attention to body language and who was participating first in order to interpret what was happening in the clip, the image of the students’ positions still in his mind after the video was turned off.

[The students] were standing. I guess it was her, two guys and there actually was a student that we didn’t see very well over here [gestures in one direction]. I don’t know if there’s one over here [gestures to a different direction], but looks like they were all working together. I would imagine at some point they were collaborating. We didn’t get to actually see that, but I would assume prior to the video, that’s what they were doing. (Anthony, Intake Interview, 9/14)

Similarly, Anthony paid attention to how the teacher was engaging students, but not so much the specifics of what they were discussing. Again, this could be due to his lack of comfort with the material, but given the way he generally talks about teaching and learning, his inclination here is to focus on academic behaviors over in-depth understanding of the material. Given his astute reading of student and teacher behaviors, but lack of deep interpretation of how much students really understand of the material (whether it is math or science), Anthony’s early noticing skills are relatively low. He is uncertain what to pay attention to, so his attention is mostly on whether or not good student behaviors are being applied and who is engaging with the material.

Jason

Context. The final MASD East dyad was made up of Jason and Mr. Waters. Mr. Waters has about 10 years of teaching experience in the middle grades, primarily eighth grade science and some social studies. This year was the first year he taught sixth grade
in a while. Jason’s and Mr. Waters’ classes include the requisite mixed grade advisory period, but their main teaching responsibilities are split between sixth grade social studies and science. It was sometimes difficult to schedule observations during Jason’s science classes, so some observations were performed in social studies, which is outside of his area of specialization. However, although Jason plans on mainly teaching science, with a possibility of also teaching mathematics, he needs to be able to teach all content areas for his middle grades certification, so it was still beneficial to co-teach social studies. This being the first time Mr. Waters taught any sixth grade material, Jason was provided many additional opportunities to see how a teacher navigates not only new curricula for his main content area (as mentioned in the section about Luke, the science curricula was switched out by the district last minute, so it was new to everyone), but also for the more familiar (to his mentor) content of social studies.

Generally speaking, their classroom was a little different from the others at MASDE, perhaps reflecting what Jason and Mr. Waters saw as the needs of sixth graders, in addition to reflecting Mr. Waters’ personal preference for order. Seating was in rows, with an aisle down the middle and a few individual seating opportunities in the back of the room. There isn’t a lot on the walls, and that which is there is mainly handwritten and directly related to either immediate concerns about expectations and content, or more broadly related to centering Mr. Waters as a friendly mentor figure for students. I feel this reflects a difficult balance Mr. Waters was trying to keep between two ideals in the classroom. Mr. Waters clearly cares about his students and is somewhat authoritarian in
that he expects students to work independently and quietly most of the time, yet also wants them to feel good about the content and being in his classroom. Jason had a different perspective, which probably made it a little more difficult for him to learn to take on more responsibilities early on.

*Initial teaching orientation.* During the first month of the program, Jason was focused on building relationships in his residency classroom and spent little time actively engaging with student thinking. Despite this focus on the classroom environment, it is possible to uncover his initial teaching beliefs/orientation. Jason’s primary goal was to be a role model for students. The idea of giving back to others in a way that he longed for, but never experienced, while growing up propelled him forward. This desire to connect with and be there for his students eclipsed his concerns about how challenging teaching can be:

> The first two weeks of school showed me how similar these students are to ones I have seen elsewhere, but also reminded me why I am doing this. I already know my connections with these students will and already are motivating me to be the best that I can be for them. There have already been moments this semester where I get anxious about all of the work and remind myself of the bigger picture, which is being the positive male role model for these kids that I never had. (Jason, Seminar Blog Entry #1, 9/7)

This interest in the well-being of students extended to the way he viewed teaching and learning. Jason sees motivation as a major player in student success. He was already seeing connections between engagement and knowledge that drove him to bring up his concern about a particular student early in the semester (Seminar Field Notes, 9/26). This student was less of a disruption and more of a silent and unengaged presence in the
classroom. Jason was concerned that he wasn’t keeping up and there was no way to know what this student was capable of because he was so unengaged (Jason described him as “muted”). Based on how Jason described other situations where students are engaged with material, it seems that his default is to assume that students who are not visibly engaging with the classroom material are not learning.

While this seems like a reasonable assumption, when working with early adolescents this is not necessarily a safe conclusion to draw. In my experience, often times middle school students will look like they aren’t listening, but in fact they are just taking in the information in their own way and on their own terms. This can be difficult for new teachers to deal with, and if the teacher expects to have all students completing worksheets or writing down notes as evidence that they are learning, then they will find it frustrating when students are not physically engaging during class. For Jason, this is the antithesis of how he thinks a classroom should look.

I know it would be my job to try to engage the students in the curriculum in a way that we’re all working together, just to use some of the things that we’ve been already learning in our classes… The student’s motivation is extremely important, the student’s engagement and everything. I even notice that in my own classroom, there are students that are getting more out of the class because they’re engaged and there are students that aren’t doing anything the whole time and I can’t imagine they’re getting much out of the class. Even just in these two weeks, I’ve seen pretty clear examples of kids that are actually understanding concepts and kids that just aren’t doing anything and I can’t imagine that they understand the concept when they’re not doing anything. Also, how am I supposed to—I can’t evaluate whether they had understand [sic] it because there’s nothing to evaluate.

(Jason, Intake Interview, 9/14)
When asked if he had spoken to the student about anything besides asking him to get to work, it was clear Jason had not yet taken time to get to know the student outside of his classroom behaviors and some initial standardized test results. At this point, most advice given to him by his peers was to get to know the student as a person better.

Combining his frustration over not being able to assess understanding of material if “there’s nothing to evaluate” with his admitting he only has asked the student to be on task, Jason potentially missed an opportunity to assess the student’s abilities through conversation. This is noteworthy because he was already aware of the power of asking good questions, but struggles with acting on this idea.

I’ve heard a lot about how important questions are and that’s something that I’ve been working on myself because I’m like a fixer or a helper. I want to just do everything for everyone but I know that that’s not going to be helpful so that’s something that I work on. I feel like I’ve already caught myself about to say something, then stopping myself and then changing it into a question that I can ask. (Jason, Intake Interview, 9/14)

Jason said he believed asking good questions is important, but he was having difficulty balancing this belief with the realities of the classroom experience. Students are not used to being asked to think independently and therefore do not respond well to his questions. Add this to his concern that he is only just starting to figure out how to ask good questions and he was feeling frustrated and at a loss to provide what he saw as ideal instruction. To him, ideal instruction involves students in the process of learning. However, this frustration is turned outwardly toward a society that doesn’t value active learning as much as he does:
[What I end up asking] isn’t necessarily always the best question to ask, but I try not to just give away the answers because that’s not helping. That’s been a little frustrating with here, too, because a lot of these kids seem like that’s what they’re used to, is just getting the answers and they’re afraid to even try… It doesn’t seem like they’re actually processing anything, it just seems like they want to have the right answer on the paper. It seems it’s more important to have the right answer than to understand why that’s the right answer. That just feels like it’s more a societal thing, like it’s important. I feel our society puts a lot of pressure on being correct and if you’re wrong, you’re a failure and that’s bad whereas that’s just not real life, that’s just not realistic at all. Everyone’s wrong all the time. (Jason, Intake Interview, 9/14)

Jason’s frustration over how students have learned to engage with school is practically palpable. He sees his role as a guide, but in a context where the people who he is trying to lead are not equipped to follow just yet. At this early stage, he can see that he is only just beginning to learn to lead students, but there is a major obstacle in the way (society’s views on knowledge and learning).

Despite the realization that society has imposed limits on the learning of his students, he holds out hope that students will one day be able to extend their knowledge of content to something more than merely regurgitating answers. This is evident when he describes how he knows that students truly understand the material being studied:

If I overheard them maybe relating the material to some other field or some other topic, and not only are they relating this to something else, but they’re also doing it in a way that’s correct. ‘Wow. That’s, you really did learn something.’ If they can take concepts that they’ve learned and apply them into different situations or even if I make it a task for them to apply a certain concept or take a certain science concepts and see where they can make sense of it in other areas, and then to just to see where that leads. If I see that they are making real connections to science and other subjects that make sense, then, I would say they’ve got a pretty good understanding of whatever that science concept was. (Jason, Intake Interview, 9/14)
Taken together, at this point of time, Jason’s orientation aligned with what Luft and Roehrig (2007) call being a Transitional/Responsive teacher, where Jason wants students to be comfortable making mistakes, trying to make connections, or trying new things, but with a focus on how students are feeling about their learning in his class. His wish is to be more in line with Responsive, where students are excited when they make connections outside of the classroom, but how his teaching was performed was more transitional.

*Initial noticing ability.* Despite his desire to create a responsive classroom setting, he began the year with a relatively low skill level when it comes to noticing. His mentor did a majority of the planning in science and all of the planning for social studies, so when his coach and I were able to observe him, it was often in a class where he had little input and therefore little opportunity to be responsive to student thinking on the fly. This resulted in his primarily focusing in on behaviors in his own classroom, both potentially distracting ones and academic ones. However, he was still looking for opportunities to try to assess student understanding, albeit in a more superficial way.

When the residents were provided an opportunity to observe math and science classes at the location of their methods classes’ field experiences, Jason, like most of the others, was attentive toward broad dynamics such as who was working and how well they were doing:

> Although the teacher was not there, I felt that the task left for the students was valuable to what they were learning in class. There were quality practice problems that kept most of the class engaged for nearly the entire period. The teacher had instructed the substitute to let the students work in
small groups on this worksheet so we could observe groups and to help keep the students engaged. When one of the students in the group I observed seemed to be struggling, another group member helped them figure out the problem. The students did not complete the worksheet, but I do not believe they were expected to. The students in my group seemed to have high success. They answered the problems correctly, but it seemed like they did not have a deep understanding of the material yet. (Jason, Small Group Observation Online Discussion for Math, 9/27)

Jason’s note about how the problems selected were enough to keep students busy (which he calls “engaged”) highlights the value of student work in his eyes. When he says they could do the work correctly, but didn’t have a deep understanding of the material, he doesn’t explain what he means by this. However, he mentions several times that his students were “motivated,” including in response to a peer who mentioned their group of students were not very successful. He even admitted he was surprised to hear there was a diversity in abilities because looking around the classroom, it looked like all students were “engaged” (Jason, Small Group Observation Online Discussion for Math, 9/27). He even equated “motivation” with completing work:

I am a little surprised to hear that the some of the students in your group were lacking in motivation. I was focused mostly on the group I was observing, but when I did look around the room I thought it looked like all of the students were engaged. Everyone in my group was so motivated I assumed that the majority of students in the classroom were motivated. (Jason, Small Group Observation Online Discussion for Math, 9/27)

Jason then rationalizes this difference in “engagement” by drawing an assumption about the layout of the class, wherein he assumes that those students who were closer to the front of the classroom were likely there because they chose to be seated there, and therefore likely benefit from more teacher contact during direct instruction. This is
interesting because this inference seems to draw upon several assumptions: that students always choose their seats and this wasn’t an odd day due to there being a substitute and several additional adults present, that completing the worksheet was entirely dependent upon student interest in doing so and unaffected by the presence of so many adults, and finally that what students were doing was completely indicative of how they normally participate in mathematics class. Given he was uninclined to think too much about the specific circumstances of their observation, or at least not enough find it worthwhile to mention these ideas when others were dissecting the situation, this suggests he was doing very little interpreting of what students were thinking about and why.

In his residency placement, however, he was already involving himself in the daily routines and structures of his classroom. This is in line with the expectations of the residency program, which ask that residents observe how their mentor interacts with students (see Appendix D, gradual release outline). His coach observed that he was already engaging students around behaviors early on:

Throughout the observed lesson, Jason circulated the room and checked on students. He stopped to speak with students individually on several occasions, and he asked them questions about the assignment they were working on. Additionally, Jason showed his ability to problem solve and maintain appropriate student behavior. As a student was talking during instruction, Jason approached him to communicate that he was being disrespectful. Jason shows his comfort with addressing students and their behaviors and the class functioned better as a result. (Coach Nan, Formal Observation, 9/13)
When questioned about how you know students are learning in the classroom, Jason has a natural interest in creating a classroom that exudes energy, where students are doing work, being on topic, and asking questions:

There will probably be a few different ways to know…. Pretty obvious one is if they’re doing a class discussion, or small group work, or small group discussion, to just walk around the room, listen to what everyone’s saying and hearing that they’re on task, and that things that they’re saying are – That doesn’t even need to be correct, just the fact that they’re on task. If I can walk around the room and hear that kids are coming up with genuine questions of curiosity, and actual interest in whatever the matter is, then, they’re obviously learning more than the kids that are not raising their hands and not doing work. I just think if you can see that they’re excited about what they’re doing, they’re probably learning more than if they’re mindlessly filling out a worksheet. (Jason, Intake Interview, 9/14)

This quote further substantiates that he has a goal of running a Responsive classroom, however, he isn’t digging into the meat of instruction and ignores the meaning of what students are working on. For example, it is fine that students make mistakes, but he needs to be thinking about how he can delve deeper into and use this information in order to adjust his instruction. At another point in the same interview he reflects with some sadness that teachers have to keep brisk paces and cover a lot of content in order for students to meet assessment needs, and he hints that a slower, deeper instructional route may be more beneficial in the long run. Being a novice at this stage, he feels ill-equipped to apply his beliefs to practice. Instead, he appreciated when he saw some indications of what he believed was good practice, and looked for these traits in the video I showed him during his Intake Interview:

They were actually engaging in the activity. They were doing the things that we’ve been talking about on our science class, successfully in the science
class with the five E’s and the inquiry and when they were talking about everything. Well, I noticed how the teacher, she would clarify some things sometimes but mostly she was just asking questions. It was the students that were the ones, mostly the girl, that were telling [the teacher] what they were doing and why. She was just asking, clarifying questions, and then it sounded like sometimes she would add a little clarifying statement like, ‘So you said this.’ That’s what it seemed like. It mostly seemed she was facilitating, she wasn’t directly instructing in that portion of the video.
(Jason, Intake Interview, 9/14)

Again, his focus was on what the teacher was doing, even when he had been prompted to reflect on what the students were thinking about. Even despite, right before this quote, noting that the students were working at what he considered a surprisingly high level as compared to what he had seen before. Therefore, although his goal was to be Responsive and he appreciates Responsive teachers, he was not yet equipped to engage in the noticing practices necessary for successfully meeting this goal. For example, as described above, when observed by Coach Nan (Formal Coach Observation, 9/13), Jason was primarily responding to behaviors and not student work, despite the fact that he verbalized the value of engaging students with their ideas. Additionally, during his Intake Interview (9/14), Jason expressed surprise that the middle school students shown in the video were working “above the level that most people of that [age] might be working at.” He contrasted this with his experiences so far, where he felt this type of interaction would not work, “especially in the school that I’m at right now, I could not see anything like that happening.” Because he expressed admiration for this type of teacher-student interaction, he was a good candidate for exploring this growth and examining how the residency experience impacted his learning.
Estelle

Context. Before launching into a discussion about Estelle, I need to pause to make an observation. The final two residents, Estelle and Vale, were located at the other study site (MASD West), which was quite different from MASDE. For one, the school is much smaller and targets not only a particular neighborhood, but also a particular subgroup of students with specific learning needs. Their school is one of the district schools specially equipped to work with students with vision impairments. The school has a generally more family-like feel to it, which is why I have decided to call each mentor by Mr. Bob and Ms. Mary. When I asked them for suggestions for pseudonyms, they only provided first names (even though they use their last names at the school), which suits the atmosphere of their school. The teachers who responded from MASDE gave last names, also suiting their school climate. Therefore, given the personality differences, I decided to use honorifics and first names for MASDW mentors.

As a result of the different cultural and academic set up at MASDW, Estelle’s classes are mixed ability, with a variety of adults coming and going. It was not unusual to see five adults moving in and out of the class any given period. Her mentor, Ms. Mary, is a genial woman with over a decade of teaching experience. Their classes consisted of one third grade math block, one fourth grade math block, one third grade science class, and one fourth grade science class. The science classes meet only a few times during the week, with one day reserved for each grade to have a double period. Their fourth grade science meets four times total, while third only meets twice. There is a set of other classes
around which the science classes are scheduled. Their classroom builds on the family feel by having swapped out desks for kitchen tables and chairs. Each student is seated at one of six dining room tables. As her students are a little bit on the younger side than is typically seen in the United States in schools with rotating classes, this care likely makes a big impact on the culture of the classroom and helps underscore the lessons Estelle and Ms. Mary teach on growth mindsets and collaboration.

*Initial teaching orientation.* One of the things that struck me early on about Estelle was her enthusiasm for bringing a “growth mindset” into her classroom. It was unclear how much of this was due to her mentor’s influence or her own initiative, but she liked to say that, “Mistakes are proof we are trying” (Estelle, Math Methods Field Notes, 9/28). This was also evident during her Intake Interview when she was describing how she wants to maximize student learning:

> Often students will say, ‘I’m stuck,’ and there'll be nothing written on their paper and I say, ‘I’m not helping you until you try it. You’re on your own first,’ because I want them to use their own brain to at least [seek] out some kind of important information before I sit down and prompt them through the question. (Estelle, Intake Interview, 9/30)

Here she shows that she believes learning is dependent upon personal engagement, and her role as a teacher is to remind students to try to do work. Although she wants students to get used to failure and try work before asking for help, she still is there to guide them if needed.

> Her view of the role of a teacher is to create an environment where students are engaged in learning and being there to support students both academically and
emotionally. Early on, her focus is on providing fun and stimulating activities, as she experienced and was inspired by growing up:

I kind of envision my role as middle school science teacher so that I could bring in all of the really great science education that I got as a student in [this city] and in college, and help give that to my students. Especially because I got a really privileged middle school education. Because I went to a really nice private school and they’ve invested a lot and really instilled environmentalism, and nature, and getting outdoors into us. And, so, I wanted to make sure that public school students also got those opportunities as much as they could. (Estelle, Intake Interview, 9/30)

This quote also suggests that Estelle has an interest in providing equitable access to public school students, who she sees as less privileged than she was growing up. Given the general consensus that this city’s schools are woefully under-resourced, her desire to provide for her inner-city students something she thinks they will not have access to without her is likely amplified by her developmental stage as a relatively young adult, fairly fresh out of college, who also worked with inner city youth in an under-sourced school setting for two years. The main outcome of this perspective is that she sees her role as teacher to be one that dictates what is worthwhile for students to experience, and not as much as one with a focus on what students need based on their own backgrounds and understanding.

In the field, Estelle’s coach observed that Estelle and her mentor worked cohesively to provide clear instruction, while Estelle admitted she was focused on helping to maintain classroom management. Her coach noted:

Estelle walked around and asked students questions about their findings. She demonstrated respect for her students by listening to their responses. As students were excited about the experiment, many of them required
redirection to stay on task and complete their work. As Estelle walked around the classroom, she spoke with students who were off-task and reminded groups of students to continue working on the questions. (Coach Nan, Formal Observation, 9/20)

Here, it is evident that Estelle was involved in both instruction and management, but even Estelle admitted her focus was on maintaining order during these early weeks.

Estelle was actively collecting and examining student work even early on. Her coach remarked that she was “very impressed by her organized, thoughtful and precise data collection methods, in addition to her eagerness to contribute to decision-making regarding her students” (Coach Nan, Formal Observation, 9/20). Estelle also mentioned looking at student work to determine student accuracy through usage of “holey cards” (math drills) and quizzes (Estelle, Intake Interview, 9/30). However, when she expressed disappointment at student scores for a recent quiz, she mainly focused on whether students knew how to do the work, but no mention of what it was they had difficulty with or how she could remediate this other than to demonstrate, often with student input, the process to be followed:

Well, because I can stand up at the board and I can say, “Okay, what is our first step?” and half of the kids—most of the kids—are raising their hands and are able to guide me through the problem. Then I’ll go around and the vast majority of them will be working. There are a few of them who don’t get it and I know that they don’t get it, and there are other reasons that they don’t get it. (Estelle, Intake Interview, 9/30)

Estelle uses these interactions to gauge ability and whether students are paying attention.

For students who are academically behind, she is aware of the need to differentiate
according to each one’s needs, but regardless the focus is more on following a procedure and less on understanding how or the procedure works.

It is possible that Estelle’s views early on are a reflection of her mainly working in mathematics classes, but she also focused on behaviors and clarifications during science. Therefore, we can interpret her statements as applying across content areas.

Given Estelle’s early focus on knowing how to do science and mathematics, while being actively engaged in delivering content, I believe she entered the program with an Instructive mindset, with some leaning toward being Transitional (Table 7; Luft and Roehrig, 2007). This is particularly true because of her interest in providing experiences to students, but limited (non-existent) discussion of what these experiences will provide her students beyond access to said experiences. Estelle’s views on science appear to be that it is more or less consistent and fact-based, as well. This, in turn, impacts her instructional decision making and processes. She wants to provide students opportunities to show what they know through a variety of assessments, but her interpretations of what these would say about student knowledge is limited. For Estelle, grades are indicative of “knowing” material and perhaps how smart students are. Her referencing “A-kids” and “C-kids” hints that her classification is superficial and based on accuracy, not a more general understanding of content that may be hidden between the lines of the work provided (Estelle, Intake Interview, 9/30).

Initial noticing ability: Even when provided an opportunity to reflect on other teachers’ interactions with students in the video shown to her during the Intake Interview,
her focus was on what teachers were asking. She paid attention to what students were saying, but using a lens of accuracy. She did not notice, or at least mention that she noticed, that there were mainly only two speakers out of the five present. When reflecting upon her observations at MACS for science methods, she noted whether students were on task or not, but made note only once about a student’s confusion and her attempt to help clarify for them. In math at MACS, she had an opportunity to work closely with two students, which afforded her an opportunity to reflect on not only what they understood about the content, but how she wished she could have responded to their lack of understanding:

Since the regular teacher was not there, it is hard to see the extent of teacher task orientation, but the staff member that was there was engaging with the students and working with them when they needed help. I was working with two students out of our group of six and one student mostly understood the material while the other was having trouble. I worked with the struggling student and it was clear that she had been taught strategies to solve the problem (Keep, Flip, Change) but she did not have a deeper understanding of how they worked… I wanted a number line or counters in front of me when working with my student because I thought they could really help her. (Estelle, Small Group Observation Online Discussion for Math, 9/25)

At this time, perhaps due to her engagement in more math than science classes at her residency site and despite her expressed desire to become a teacher to specifically teach science, she was more in tune with trying to think about how she might adjust instruction to help deepen a student’s understanding of the material. Yet, her focus was still mainly on instructional choices that reflected accurately meeting content goals rather than specifically trying to engage students in their own learning.
When prompted to examine the interactions of the video of a science class, Estelle made note that the teacher used prompting questions to get students to give precise answers:

[The teacher in the video] was making sure her students were being really specific with their observations and making sure they were articulating their ideas using the scientific language that I guess they expect in the classroom. (Estelle, Intake Interview, 9/30)

She also interpreted the students’ answers to questions as indicating they felt their experiment could be better/didn’t go the way they expected:

The kids were trying to explain their experiment and then they were pointing out some reasons why they don’t think they saw the experiment fully through ‘cause they said the water was not the right temperature for them. So, they were noticing issues in the experiment and that was prompting why they weren’t getting their desired results, sort of the best possible results. (Estelle, Intake Interview, 9/30)

Here Estelle shows that she paid attention to the teacher’s questioning technique, but only viewed student responses with a lens toward assessing student knowledge or ability. She hints that there is a chance to delve deeper, but she tries to fit the interaction into something that was primarily about focusing on “the best possible results.”

Similarly to Luke, Estelle’s early abilities to notice are aligned with her beliefs about teaching and learning. She tended to ask and pay attention to factual questions and task-oriented behaviors. I categorize her early abilities and noticing skills to be of moderate sophistication overall, where she is actively interpreting the meaning behind student responses, but her interpretations are limited to a concrete goal rather than reflecting the epistemological natures of math and science or other broader understanding
of the content. Over the course of the semester, it is interesting to watch her develop, which will be explored more (along with everyone else’s development) in Chapter 5. 

Vale

Context. The final primary participant, Vale, was unique and provides a counterpoint to the way other residents spoke about evaluating student thinking. Like his peers, he wanted students to provide unique responses in order to prove they understand content, but he wanted those responses to be more than merely restating what the teacher has provided them.

His context was similar in many ways to Estelle’s, particularly with regard to the culture of a small K-8 school as compared to the larger 6-8 that is MASDE. Vale and his mentor, Mr. Bob, teach seventh and eighth grade science. Their classes are on a somewhat rotating schedule with some block periods intermixed, and not one class had as many as twenty students. Mr. Bob is quite different from Ms. Mary—more authoritarian, like a father figure. However, his take on teaching and learning is very Socratic and classes involve a lot of discussion that revolves around his questioning students to guide them toward using critical thinking to make sense of material (more on this below). Vale and Mr. Bob are a good pairing in this way, as Vale’s own love of science is rooted in questions.

Initial teaching orientation. Vale’s interest in teaching and learning science through questioning is driven, in part, by how his parents, who were both scientists, influenced his love of science—through purposeful exploration of scientific ideas. He
sees being a science teacher as a way to influence future generations’ opinions about conservation and environmentalism. His interpretation of what is science and valuable about learning science are tightly intertwined between what his family encouraged in him and his experiences working in nature conservancy:

The best way to make a change is to educate the people around you about the decisions they make and how those decisions affect the environment around them. I quickly grew to admire the people who could get kids excited about conservation and recycling. And I realized that the reason why I had such an appreciation for nature is because it was fostered in me at a young age. I want to be someone who can make science exciting, fun, and interesting for the young people who come into my classroom. (Vale, Seminar Blog Entry #2, 9/13)

Like Estelle, Vale’s inspiration to become a teacher was tied to wanting to provide valuable experiences to students, but unlike her, his focus was more on the potential outcomes (nature conservancy) and who is participating rather than providing specific experiences. This difference in outlook is also reflected in how Vale approached working with students in classroom settings. Regardless of the context, he made note of who was participating and rationalized their participation as part of his sense making process. For example, when working with students during his first math methods-based field experience, he made particular note of how different students interacted with the same material:

Two of them started before the substitute finished talking and completed the first side of the worksheet before the period was half-over, they needed no intervention and me and my partner spent the whole period working with the other three students. It seemed there was a wide gap in the ability and motivation between the these two and the other three. The other three students were much more socially-inclined and it took us 10 minutes to get one of the students to put pencil to paper… [The group of] three were more
socially motivated we were able to turn this into a bit of a friendly competition between the three to see who could answer each question correctly. These students almost finished the first page of the worksheet and I was very happy with what they had accomplished in this period. (Vale, Small Group Observation Online Discussion for Math, 9/24)

Similarly, he continued with this pattern of interpretation when examining the video of the science, where he didn’t merely report which students were saying what, but included a possible explanation for why:

[The] first thing that stuck out to me is that not all the students were putting forth the same amount of information. So what I noticed was that the person who did the talking was the student all the way on the right. And then the student in the middle interjected a fair amount but often was almost cut-off by the student on the right. And then the student all the way on the left I think put in one comment and felt like he didn’t need to kinda say anything because everyone else in this group would do it… [The student who kept responding] was maybe more confident with [the experiment] or had done more work on the actual project as well (Vale, Intake Interview, 9/30)

In both of these examples, Vale’s initial reaction is to focus on who is participating and how this is demonstrated by their reactions to classwork. He sees this as relevant because it is tied to motivation, but also, as mentioned in his own motivation to become a teacher, what he sees as the ultimate purpose for learning science—to protect the environment. This purpose-driven lens toward teaching is also reflected in how he describes true learning:

I would say that, you know, when they’re able to, again, kind of use it in a different context, it’s a huge part of it. But also being able to teach it or help a friend out with it or to apply the knowledge and know exactly kind of what is important to look for and what is maybe less important.

Being able to understand, if you’re doing certain measurements, like if you’ve been measuring plants for weeks, right? And then you can put them in an entirely new environment and they could think, ‘Oh, do you know
what might be important for me to know in growing or raising this thing, you know? I need to know its size. I need more than one measurement for its size because maybe leaf count is more indicative than plant height.’ Right? ‘I need to look at the factors that influence it, such as—’ With a plant it would be water, right? And it would be sunlight.

So maybe for this hamster it’s food and it’s water. But being able to kind of take those same ideas and apply it in a different situation is one of the best ways in my opinion that you can tell someone’s learning something. (Vale, Intake Interview, 9/30)

Vale’s prioritizing application of knowledge is similar to what Luft and Roehrig (2007) refers to as Reform-based, a student-centered way of looking at learning where true learning is through application to a new situation. In this way, Vale is unique amongst the participants. Rather than assessing student understanding as being merely evaluating the accuracy of a response, he wants to see students be creative and critical, applying information he provides them to new situations.

Vale believes the teacher’s role is to help students “find a way to figure [science content] out” on their own because this “was a huge part in what made [him] love science. And it’s something that [he’d] like to be able to create in the classroom” (Vale, Intake Interview, 9/30). However, despite his tendency to lean heavily toward Reform-based beliefs, he still has some slightly more traditional beliefs about the role of teachers that place him more firmly in the Responsive teaching orientation category.

Initial noticing ability. Despite Vale’s interest in incorporating critical thinking and active relationship building between students and teacher, he seems very willing to accept and admire his mentor’s positioning of himself as the sole leader and guide to learning in the classroom. This is reflected early on in how he talks about his mentor’s
way of teaching even behavioral expectations, explored below. Between his student-centered lens for teaching and learning and his tendency to early on pay particular attention to the purpose behind the questions teachers ask, and not merely what kinds of questions are being asked, Vale was very attentive toward the interplay between how a teacher asked questions and the goals the teacher had in asking questions:

[The] teacher [in the video] was asking questions and trying to get them to think more critically on what they were observing and trying to see what observations they thought were most relevant. [The teacher] didn’t really pick on students individually, just kind of passed it to the group, and she seemed to be trying to direct them down a certain path. (Vale, Intake Interview, 9/30)

Another way Vale stood out is that Coach Nan also noted that early on Vale paid attention to more than classroom management, but also was actively involved in planning and implementation of instruction in the classroom (Coach Nan, Formal Observation, 9/20). Vale’s description of how his mentor’s classroom works reflects the mentor’s natural ability to use questioning to help students take charge of their own learning, in this case about classroom expectations:

Instead of just correcting the behavior, [my mentor] asks the student why they are doing what they are doing, and continues to put the student on the spot until he feels that all the other students understand what behavior is inappropriate and why. (Vale, Seminar Blog Entry #1, 9/6)

Then Vale goes into great detail after this about how this looks using a detailed description of a specific event:

An example of this would be that you put your backpack on the table to take out your notebook. Mr. Bob would say ‘Jeremiah, what are you doing?’, [who would not know what Mr. Bob is looking for]. And he would say ‘does anybody else have their backpack on the table?’ and [Jeremiah] would say
no, I guess not. [Mr. Bob] would pause and look around the room and ask someone else a question… [If that student] didn’t know then he would ask someone else. Then he would say ‘so nobody knows, okay, raise your hands if your backpack has been on the ground today.’ As students raise their hands he would then turn his attention back to the perpetrator of this heinous action and say ‘now do you understand why I don’t want you to put your backpack on my table?’… [The student would explain the connection] and [Mr. Bob would ask the class if they understood.]… Then you get a great pause as he looks at each individual student to gauge for himself whether or not they have understood him. (Vale, Seminar Blog Entry #1, 9/6)

Although not specifically about content, this recollection suggests this is typical for how his mentor interacts with students, where the mentor carefully questions and assesses student understanding in real time.

How Vale described how students responded to direction and teacher questions regardless of context (video, observation of a new context, observation of his own classroom setting) and tying these directly to the purpose behind the questioning is useful for assessing his noticing ability. I rate Vale’s early noticing ability as being relatively high, albeit still of fairly moderate sophistication due to low level of immediate responsiveness. At this point he respected the ability to, and was also somewhat able to, assess student understanding of content or concepts in the moment. He sees questions as being a gateway to a conversation where knowledge is co-created between students and teacher, and, further, this reflects his views of science, which in turn is reflected in his beliefs about teaching and learning.

Research Question 1: A Cross Case Analysis of Noticing Practices

Professional noticing practices, i.e., attending to, interpreting, and responding to student thinking, were observed in-the-moment as is part of the definition of noticing
used in this study. Research question one focuses on what noticing practices the residents engage in throughout the semester. To explore these practices, I also looked for potentially informative processes adjacent to these practices that could inform how preservice teachers learn to think about and engage with student thinking during classroom instructional time. For example, I analyzed data with an eye toward using student work to inform lesson planning, how mentors and coaches engaged in discussing student thinking with residents, and whether/how residents made connections to student thinking when reflecting back on class or responding to prompts in a variety of contexts. The following section describes the variety of ways in which my primary subjects engaged in noticing throughout the semester.

The Range of Noticing Opportunities

The vast majority of opportunities taken to engage with student ideas were around fairly superficial content such as behaviors and accuracy of responses. Behavioral concerns were the most frequently and continuously engaged in throughout the semester, followed by those relating to whether or not students were providing correct responses. Periodically, primary participants engaged in practices that involved deeper reasoning levels, but mostly these opportunities were demonstrated by mentors rather than engaged in by PSTs.

As per the program’s own guidelines (Appendix D) for September and beyond, in addition to establishing professional norms around arrival and behavior, teacher residents are expected to:

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• Become familiar with students and all members of the school community
• Observe classroom environment, management strategies, and teacher-student interactions
• Become familiar with school and classroom routines and procedures
• Review all handbooks and policies for each school, district/charter
• Learn students’ names and take attendance
• Assist with organization and preparation of classroom materials
• Establish regular co-planning and reflection times, at least weekly
• Co-plan with the mentor as the lead; be involved in all aspects of planning
• Co-teach with the mentor teaching and the resident observing or assisting
• Receive regular feedback
  o Mentor provides informal feedback daily and more formally during planned planning/reflection times
  o Coach will observe and provide feedback at least once
  (MATR Gradual Release Calendar, September)

Relevant responsibilities increase over the first few months to include paying attention to how student data can inform decision making (October), how mentors question students (November), and how mentors adapt instruction (December). As the focus of the program’s early expectations are primarily around behaviors, it is unsurprising that these are the main items of concern. However, there was a fair amount of interpretive latitude taken when mentors, residents, and Coach Nan discussed progress during interviews and in their biweekly collaborative logs.

In courses, noticing was implied, but rarely explicitly addressed. In science the expectation that teachers plan instruction to elicit and respond to student thinking in was taught and addressed through the use of the 5E framework (Bybee et al., 2006) to design and teach a three-lesson unit that was, at the very least, responsive to student abilities and interests. In math, in addition to planning and teaching three 5E lessons (Bybee et al., 2006), PSTs were walked through repeated explorations of the logic behind mathematical
algorithms in order to best address misconceptions and help students think critically about the what and why of mathematical reasoning. Meanwhile, in their reflective seminar, the instructor regularly used Number Talks (Parrish, 2011) to discuss the creation of norms around epistemological issues in mathematics that could be carried over to science, in that Number Talks provide a protocol for asking students to share their ways of approaching problems while using critical thinking skills to identify best practices. Seminar also allowed for the instructor and me to ask questions of the PSTs that encouraged them to think about the reasons behind student actions in class and how to adapt instruction to fairly evaluate students about their content understanding, beyond merely repeating back what they were told. Even the residents’ Child and Adolescent Development class offered opportunities to think about how the developmental abilities of students impact their responses in class and how to possibly address issues of equity and fairness in discussion.

The following subsections outline themes I saw that essentially describe skills needed to establish noticing skills. I call these “noticing adjacent” skills and opportunities. The themes cover the noticing adjacent practices I observed throughout the semester, paying particular attention to events relating to the participants’ field-based experiences because those were where they had the most opportunity to engage in noticing practices. In the next chapter, I will explore the temporality of these experiences on a case by case basis and how individual contexts may have impacted not only what
opportunities were afforded for exploring noticing, but also how noticing adjacent skills were (or were not) incorporated.

Noticing Adjacent Skills and Behaviors

The following themes stood out not only as I was collecting data, but also upon multiple reviews of each artifact and interview. It became clear to me that despite only six participants involved, there were interesting patterns and trends that could be put into groupings. The ones discussed here are all, in one way or another, related to the act of or learning how to enact noticing.

Beliefs About Learning

This theme was used to label references related to my use of Luft and Roehrig’s Teaching Beliefs Protocol (2007) at the start of the semester. I built my study with an assumption that personal beliefs about teaching and learning has an impact on whether or a preservice teacher would learn to notice. Beliefs, however, are complicated and do not always directly translate into a clearly associated outcome. As my analysis shows, my primary participants began the year with a range of teaching orientations (Table 7). Most leaned a bit more strongly toward teacher-centered instruction and one leaned more heavily toward student-centered instruction (Luft & Roehrig, 2007).

By the end of the semester, my primary participants’ beliefs had shifted a bit, in ways that reflected the types of interactions they had in their residency classrooms. Vale, who began the year with a highly responsive perspective (responsive with a tendency toward reform-based), did not change much, but he appeared to have increased his
reform-based orientation (Table 7; Luft & Roehrig, 2007). I find it interesting that this participant was in a classroom that was very discussion-oriented and the mentor-resident dyad communicated very well. Vale and his mentor, Mr. Bob, had highly aligned belief systems that also aligned with reform-based practice (Table 7; Luft & Roehrig, 2007). Anthony, who had a small (negative) change had some differences in opinion from his mentor, to the point where their communication was strained. There was a mismatch between their beliefs about the purpose and goals of teaching, where Anthony was far more concerned about being a role model and focusing on the general well-being of students than Mrs. Hartman. The participant who started with the lowest level of student-centered learning beliefs, Janice, increased the most, however she moved merely to 

instructional on average from traditional (Table 7; Luft & Roehrig, 2007). This possibly reflects the fact that Janice was in a very student-centered classroom with a highly responsive instructor, however Ms. Gilmore had a difficult time with unpacking her practice, although she tried valiantly. The residents who decreased the most experienced relationships with mentors that had high degrees of communication, however either encountered a great deal of classroom management issues (Luke and Jason) or were more closely tied to pre-set curricula (Estelle). The reliance on following the written curriculum may have been the bigger issue, but having classroom management issues could increase the reliance on pre-existing curricula.

Besides using the TBI (Luft & Roehrig, 2007) scoring guide, the codes that helped to solidify this theme include identification of moments throughout the semester
when participants discuss issues related to what it means to them to learn and why they chose the instructional decisions they made. All agreed learning needs to be assessed in some way, but what they are assessing is a little different depending upon their orientation. Teacher-centered participants tended to talk about things relating to the idea that students need to be provided specific experiences and then assessed for ability to restate the teacher’s provided explanations. The more student-centered the mindset, the more flexible they were in their definitions of what it means to learn science and mathematics or what learning looks like in the classroom.

Generally speaking, this theme highlights the importance of accounting for PST beliefs before and during their field-based experiences. Mentors can make or break these experiences, especially based on my observations about the role of mentors as models of classroom management and curricular guide. Because noticing is dependent upon being familiar with curricular goals, it makes sense that organized classrooms with responsive mentors who are gifted at unpacking their own noticing practice can help nurture development of these practices in novice teachers.

*Observing Noticing Skills in Others*

As mentioned above, whether or not mentors are engaging in and examining their own use of noticing appears to be important. Therefore, it is unsurprising that this theme arose. In fact, I couldn’t fully discuss beliefs and the patterns of how beliefs appeared to change without referencing whether not primary participants were able to observe and engage in discussion about noticing practices in their residency placements.
This theme was identified through two major sets of codes. One set was looking more closely at the patterns of change in beliefs on the level of the different pieces that make up teaching orientations as defined by the TBI (Luft & Roehrig, 2007), which is illustrated in Table 5. The other were clear examples of times when mentors or others (university instructors and coaches, in particular) modeled using student ideas to think about curricular trajectories or at least adapting instruction on the fly and whether or not the residents appeared to take advantage of these opportunities. The more often mentors, in particular, provided examples of how to use student ideas to adapt instruction, the more residents appeared to pick up on these ways of thinking about things themselves.

As discussed above, however, the ability to use these examples appeared to be partially, at least, related to how well the mentors unpacked their own practice and how well the mentors helped the residents work in organized and well managed classrooms. The use of curricular materials as doorways into student thinking rather than merely measuring student knowledge also could be connected to this theme, but more research needs to be performed to explore this relationship directly.

*Interest in Student Potential or Ability*

A third major theme arose from open coding of the evidence. I started noticing that I was developing a set of codes about primary participant perspectives about student abilities. This included codes relating to diverse learners, thinking about what the skill levels are of students, what their own expectations are, and their response to seeing what students are capable of once it was modeled for them or shown to them directly.
It was particularly striking that one of the primary participants who had a negative change in their teaching orientation was quick to want to reduce rigor based on their perception of what students were capable of in their school site, even despite seeing comparable students at a different site (such as the video used in my interviews or when they observed teaching at another school in the district). It appears that their experience with a disordered classroom and students who struggled with using critical thinking skills (thus increasing the disorder) may have resulted in them wanting to focus more on students’ academic skills, which is a more *instructional* perspective. Meanwhile, when other residents were either distracted by classroom behaviors or only engaged in examining student work with an eye toward moving forward to the next lesson, they tended to redouble efforts to keep their classes orderly rather than try a new tact that would involve more focus on cognitive engagement in students. They were less focused on motivation and more focused on creating an orderly classroom culture or academic structure.

*Reflective Practices*

Another key theme that emerged from my analysis was how much residents engaged in various reflective practices. Reflective practice includes the broadest of codes. I decided to group together everything from when residents made connections between two events to how much time and detail went into their interpretations of events and opportunities. This theme also includes references to times where residents engaged in thinking about noticing practices, but outside of the hustle and bustle of class.
Some residents were more reflective, some were less so. Those residents who were extremely reflective tended to ask a lot of questions and provide deeper explorations of their experiences all throughout the semester. For example, Luke often would look back at his activities and ask for input on how he can better serve students, such as through increasing his reach to more students (Post Observation Interview, 10/4), exploring new options for eliciting student responses (Post Observation Interview, 10/25), and meeting behavioral expectations while also moving the class forward academically (Post Observation Interview, 11/20). These residents also increased in their noticing ability a bit, at least in terms of trying to look for ways to engage students in their own thinking. The least reflective of the residents made the least amount of progress in learning to think about the meaning behind what students were saying beyond whether they were correct and appeared to be engaged; however, by the end of the semester they did start to shift their attention to trying to figure out what it means to be engaged and how this translates into student ability to succeed. This shift is exemplified by Janice, who at the start of the semester was primarily concerned with providing support for or copying her mentor and telling students whether they were correct or not (Post Observation Interview, 10/4) but who ended the semester considering more about the way she was asking students questions that guided them to correct responses (Post Observation Interview, 11/20). When asked to explain why this new focus was working well for her (she indicated she was “proud” of her questioning), she was still stopping short of exploring the patterns with students, resulting in Coach Nan pressing her to think
more about this deeper meaning (Post Observation Interview, 11/20). Although Janice’s ability to attend to student ideas increased, she was still likely limited by her definition of what it means to understand the material (Table 7). My interpretation of this disconnect is that Janice was being encouraged by her mentor and coach (and to some extent my questions) to consider student thinking, but she was still not seeing a full picture of what students could be thinking about and how to address this.

Whether and how deeply residents reflected may have an impact on PST ability to learn to notice, however it is difficult to tease apart the roles of a strong mentor, explicit instruction in noticing, and the baseline belief systems in this process. This will be discussed further in Chapter 5 as I go through the chronology of each resident and their experiences and growth throughout the semester.

Seeking Feedback From Knowledgeable Others

A final theme related to reflective practice, but more specifically focused on using other humans as resources, was the willingness to engage with knowledgeable others. This theme builds upon the situated learning framework described in Chapter 2. I hypothesized that residents would need to have access to knowledgeable others and integrated practice during their teacher training. Therefore, this theme is distinct from reflective practice because it is about how residents engaged others in their journeys and whether or not they sought out specific people for help and took the time to really incorporate what others had to offer into their practice.
A major implication of this theme is alluded to above in my brief overview of several other themes, in which the relationship between the PSTs and their mentors was very important. Some of the things that jumped out to me were whether there were alignments between beliefs and practices. For example, I looked at whether the messages being shared between mentor, coach, and university instructors aligned with each other and when they didn’t, how the resident responded. But this theme also brings to light the importance of the alignment between university coursework and what residents are seeing and doing in the classroom. Mismatches at any point appeared to make it more difficult for residents to assimilate new ideas.

Conclusions for Research Question One

Looking for noticing in contexts where there are quite variable opportunities available allowed for identification of broader experiences that could contribute to the development of these skills later. Each theme described covers different aspects of what I argue are foundational skills needed for effective noticing. All of these themes are also important for making sense of what my primary participants experienced during their residencies. In the next chapter I will walk through the journeys of each resident, drawing connections to these themes. Then in Chapter 6, I will explore more of the implications of these themes, how they might connect to one another, and how they may lead to improvements in our approach to teaching future teachers to engage with and adapt to student ideas about content.
CHAPTER 5
DEVELOPMENT OF NOTICING SKILLS

Introduction

In the previous chapter, I introduced the cases and their initial statuses in terms of teaching orientation and noticing abilities. The following chapter explores Research Questions 2 and 3, which ask about the development of noticing practices over time and a comparison of these developmental patterns between content areas (mathematics and science). First, I will walk through the individual cases of my quintain, paying particular attention to opportunities and challenges afforded to each primary participant in terms of noticing and noticing adjacent skills (Research Question 2). The chapter will then move into a discussion of the patterns I observed between those who were primarily teaching mathematics and those primarily teaching science (Research Question 3). The chapter will end with some assertions I have developed based on my observations and analyses.

Research Question 2: Opportunities to Engage in Noticing

Case studies are an effective way to describe and explore the varied opportunities residents had for learning about and practicing noticing. Below I describe each case’s experiences during Phases 2-5, while also addressing the meaning I derived from the different pieces of evidence I had at my disposal. Cases are organized as they were in Chapter 4.
The Cases

Luke

Luke started the year with a positive outlook and interest in creating a classroom culture that encouraged dialogue between student and teacher (see Chapter 4). However, his mental concept of what teaching and learning look like in a classroom was balanced between the needs of the teacher and the needs of the students, with a learning goal for students that consisted primarily of their learning how to explain scientific concepts in their own words. His idea of a classroom was fairly teacher-centered. Yet, he still allowed for the idea that students should engage in making sense of the content through discussion, just with him as the leader of this discussion. Most notably, he was able to rapidly determine needs of students “on-the-fly” during class, but his interpretation of these needs was based solely on his determination of how accurate their responses were, and did not involve much expansion of thinking beyond what was defined by the task at hand.

Finding one’s footing. As the semester developed, Luke continued to bring in his strong questioning techniques, however, he had a small setback between when his coach had observed him in September and when I observed him the first time (his coach’s second observation). Originally, his plan had been to start implementing and facilitating the entry tasks each day (Luke & Ms. Childs, Collaborative Reflection Log, 9/24). However, in the week and a half between setting that goal and my first classroom observation, various behaviors had proven too challenging to control. Therefore Ms.
Childs had begun to step in and facilitate the entry tasks. Instead, they channeled their efforts into splitting the class in order to facilitate more small-group instruction. Luke began taking small groups of students aside to work on a microscope laboratory project. This afforded him an opportunity to build relationships and practice guiding students in small groups, while also helping to keep moving the class forward through providing focused training on the use of microscopes.

It was obvious during my first residency-based observation that Luke was gaining confidence working with students in small groups and asking them questions. He readily circulated the room fielding questions and stepping in to redirect student attention. He also spent considerable time talking to students about the assignment they were doing. What was remarkable about this was how he used questioning to encourage students to engage cognitively in the work. Although focused on accuracy of responses, Luke was able to ask guiding, and sometimes open-ended questions, to help students make sense of the material for themselves. During this lesson on the different forms of energy important for the action of a roller coaster, Luke led a small group of three students through the following conversation while students were working on a table-length white board showing a drawing of a roller coaster:


Student A points to a location near the top of the tallest peak.

Luke: “What’s the point of maximum PE?”

Student B points to top of peak.
Luke: “Mark it up! Where’s the highest KE?”

Student A writes P at the top of the hill and X near base of tall hill.

Luke: “Awesome. Where’s the highest part? And therefore has the highest what?”

Students point and mutter “potential energy.” (Observation #1 Field Notes, 10/4)

Although Luke’s specific questioning during this interaction was focused on accuracy and making sure the group was moving forward as assigned, his coach made note that she felt his questioning was a little deeper depending upon who he was talking to and where he was in the assignment. She and I were seated in slightly different areas, so our abilities to listen in varied. For example, she made note of questions he asked a group that may have been a bit more open-ended, yet still highly focused on moving students along a particular lesson plan:

As students began to discuss roller coasters as they pertain to kinetic and potential energy, Luke circulated the room and spoke with different groups. He stopped to work with one specific group who was struggling to begin. He led the students with questions, asking such questions as ‘What does kinetic energy involve? What happens after the engine pulls the car up to the top? Then what?’ which facilitated a conversation leading to further understanding. Students were led to discovering the information they actually knew and how they could use what they know to complete the assignment. (Coach Nan, Formal Observation, 10/4)

Throughout the semester, Luke would comment on different questioning techniques he observed, including in reference to the types of questions I asked during my formal and informal interviews. It was clear from the debrief with his coach that he ranked questioning as a pretty important pedagogical tool:
Luke expressed that one of his goals in deepening students’ understanding is to figure out a way to check for understanding among an entire group of students, instead of on an individual basis. We discussed how Luke could ask each member of the group a different one of these questions, holding each group member accountable and checking for understanding on a broader level. (Coach Nan, Formal Observation, 10/4)

The fact that he wanted to extend beyond the one-on-one questioning he was already engaging with shows a very high level of self-awareness. His coach encouraged him to pursue this and think about how different types of questioning can lead to interesting discussion and deeper understanding. She also pointed out that in order to do this effectively, he needed to be even more involved in lesson planning:

[Once] you have more of an active role in lesson planning, the questioning that you were mentioning, wanting to improve, will [automatically flow] even more because when you have this exact idea of where [you’re] going today [and in the future]. You'll know the content even more thoroughly, and then – because you know where you’re heading… You’ll kind of know what kind of questions you want to ask, because they’re gonna [sic] be relevant in the upcoming days or weeks… (Coach Nan, Coach Debrief #2, 10/4)

Luke’s mentor agreed that he needs to know what the lesson is about, but emphasized the importance of practice and experience because it can be difficult, especially early on in a unit, to “suss out” what students mean and adapt instruction accordingly. Ms. Childs eventually came to the conclusion that the main way to learn to identify what students mean and need is through experience:

And it’s part of the beauty of teaching the same thing more than once. Right? You know, me teaching the seventh graders again, [I’ve] got a better idea of where to aim, and what’s gonna [sic] be independent, what’s going to be a stretch, and give them is what they need when you’re asking them to do something that’s a stretch. (Ms. Childs, Post Observation #1 Interview, 10/4)
Here she implies that one has to also reflect on these interactions because one cannot learn from experience without reflection. I interpreted Ms. Childs’ repeated pointing toward experience as this being the best way to learn to teach. Ms. Childs modeled this reflective process by continuously engaging in discussions with Luke about how lessons proceeded and ideas for improving next time.

Luke’s mentor was very open to discussing these issues and more, but also had a tendency to dominate the post-observation conversations a little. This was sometimes useful because it afforded me an opportunity to get a more thorough picture of who Ms. Childs is, but also get a peek into their working relationship. Ms. Childs is pretty open and honest about what she sees as her shortcomings. Aside from classroom management being an obstacle, she admitted that she has never had a student teacher before and found it challenging to unpack her practice. This is additionally difficult, according to her, because the district changed the science curriculum last minute. Ms. Childs admitted that due to her having taught middle school science for so long, she is comfortable doing all of her planning in her mind and essentially teaching each day on-the-fly. Even though she clearly would check in with Luke about her plan for the day, she may not have been as good at unpacking her practice as he needed. She knew it was important to do this unpacking, but wasn’t sure she would be able to do it very well.

*Learning by doing.* Despite feeling challenged by the process of being a mentor, Ms. Childs and Luke maintained a positive and constructive relationship. Luke respected Ms. Childs’ relationships with students and her ability to hone in on the areas in which
students are struggling. Ms. Childs, likewise, appreciated Luke’s questions about practice and eagerness to learn. As the semester continued, however, Luke became more and more concerned about classroom management, which appeared to take precedent over his interest in building on what students already know.

One of the ways Luke demonstrated that behavior was of major concern was in how he described trying to leverage the “fun” side of science to convince students to do the hard work.

We were talking about what they learned, what they liked and what they disliked from the roller coaster project. Some of them have the response, it’s just as simple as, ‘I liked doing something, getting up out of my seat, doing something hands-on, and that's great.’ I tried to use that as a moment to say, ‘You will be doing these things in science, we need you to be on task and well-behaved for the other portion of things in your seat activities so that we have the opportunity to do it.’ (Luke, Post Observation #2 Interview, 10/25)

It is common that teachers, novice or otherwise, focus on motivation through activity, but it is important to extend that focus beyond having fun and instead engaging in minds-on work (Ainley & Ainley, 2011). Therefore, it is unsurprising to see Luke make this connection, but still disappointing that this gets translated into reduced access to cooperative and student-centered learning activities. Even when discussing an activity that involved assessing students’ content knowledge through an online trivia game, Ms. Childs kept moving the discussion back toward the challenges of working with diverse learners and middle school students, indicating her inclination is to focus first on behaviors rather than understanding of content. When his coach and I would offer up alternative ways of running these types of activities, Luke showed interest in engaging in
these activities, but his mentor often offered up reasons for why these would not work in
their setting, such as cost, students’ abilities to focus or work together, and their current
status in terms of managing the classroom (Post Observation #2 Interview, 10/25). This
suggests that Ms. Childs may have been derailing Luke’s ability to learn about adjusting
his practice with an eye toward content-driven pedagogical choices.

Despite these distractions, Luke was pretty in tune with where his students were
in terms of their general understanding of the content. At the start of my third
observation, Luke engaged students in an entry task to check their understanding about
the roles of different organelles. One student asked if the bark of a tree is made up of cell
walls. Luke immediately turned this around and connected cell walls and bark, but
clarified that bark is made of cells. When asked afterward why he made this connection,
he said that this student tends to be absent a lot, but he knows she is intelligent, and when
she quietly said something about protection in her answer, he knew she was trying to
make sense of cell walls, not bark, per se. Luke’s ability to recognize the meaning of this
student’s question and tie it back to the purpose of the activity was an excellent example
of his potential to notice student thinking at a high level. This growth was heavily
influenced by his mentor’s abilities.

Looking ahead to student teaching. Luke’s growth as a teacher was fairly parallel
with Ms. Childs’ growth as a mentor. As she started to allow him to take more ownership
of thing like a positive behavior management plan and exploring more student-centered
learning tasks, she also began reflecting more on why certain activities were working,
beyond the limitations of students. For example, she had a willingness to incorporate more diverse ways of supporting all students, such as through the use of sentence starters and modeling. She also encouraged Luke to keep track of successful ways to guide students to be mindful of the content over the finishing of the activity:

I heard you when you were talking to this group, you gave them some advice about how to share. That kind of thing, are you making notes for yourself for next time? These are things that you’d like to hit head-on before letting them go so that you’re not just like putting out fires. (Ms. Childs, Post Observation #3 Interview, 11/20)

Ms. Childs is referring to some careful guidance Luke gave students about how to choose which information to share during a jigsaw and what to write down when generating consensus answers to group questions. In this case, she extends this observation to encouraging him to include this cognitive engagement during the initial setup of the class activity and not merely focusing on how to complete the activity from a logistical perspective.

The need to balance classroom management and learning tasks was something Luke’s coach was also trying to address. Often her feedback throughout the semester related to the cognitive engagement of students, but as the semester wore on, her focus drifted also toward behavior management. In her final observation of Luke for the semester, a large segment of her feedback was on how Luke was addressing behaviors, in particular where he was seeking support and ideas, and what these mean for his practice:

Luke has the work ethic, intelligence, patience, and drive to be successful as a teacher. I encourage him to really follow through with some methods, as the classroom behaviors are prohibiting him from focusing on improving his teaching practices. (Coach Nan, Formal Observation, 12/5)
It is interesting that this comment comes between when I last observed his classroom and the start of his formal student teaching. I have to wonder at the timing, as it was the last time his coach would observe him before his responsibilities in the classroom would be ramping up during the official student teaching phase. Previously, Coach Nan’s feedback contained a lot of praise for Luke’s ability to question students and address content-related issues. I am not aware of what else happened during this observation, but perhaps some incident occurred that made Coach Nan concerned that he would have some difficulty taking on the myriad responsibilities required of a full time teacher come January. It could also be that Luke was concerned about behaviors, himself, and drove the discussion toward classroom management and away from content-driven pedagogy. Ultimately, this is part of a pattern I see across the residents where at this point in time (the end of the first semester), if they are having difficulty with classroom management, they redouble their efforts to gain control of the classroom rather than refocus on content-driven teaching strategies.

*Reflecting on lessons learned.* In terms of paying attention to students’ conceptual understanding in science, it appears that Luke’s development was at least partially influenced by how well he knew his students and his comfort in the classroom. Early on, he tended to default to what his mentor was doing, standing back and allowing her to take the lead when it came to addressing content. As he gained more confidence and familiarity with students, he also began to ask more of them, looking for more ways to encourage students to share their ideas and engage cognitively. This was especially clear
when you look at his lesson plans for his science methods course as compared to what he was asking of students in his regular classes.

Between when Luke and his partner wrote and practiced their lessons for science methods and when Luke completed his final performance assessment for the same class, he made a major modification in the structure of the unit. The first time through, their lessons were relevant to the topic at hand, but very much focused on providing students with shared experiences to base their learning on and then develop lesson from there. Later Luke re-organized the order of content to build more upon itself, thus opening students up to the option of building upon their own learning (Science Methods Final Reflective Essays, 12/14). It is difficult to know the exact reason for this choice, but given his decision to also examine why a particular student was struggling academically in his class and his attempts to help this student redirect his energies towards learning (Child Study, 11/28), perhaps his decision indicates he was focused on content understanding more toward the end of the semester than when he originally wrote those lessons. In the end, Luke learned that students have multiple needs that need to be met in the classroom (in this case, social ones were particularly relevant), but through directed feedback and guidance students can be more successful (Luke, Child Study, 11/28).

He also addressed the need to consider where students are in his decision to switch the order of the lessons from what he and his partner originally taught. Originally their lessons jumped from talking about forced perspective (a scale property) to mass (as an intro to gravity) and then to eclipses. Upon reflection, Luke realized that the concepts
needed to understand eclipses is more closely related to forced perspective than mass and therefore it made more sense to swap the order of the gravity and eclipse lessons (Luke, Science Methods Final Reflective Essays, 12/14). As he described in his justification of the lesson itself, this ordering allows for students to build up their conceptual understanding of the scale properties of solar bodies and how these impact their motion (Luke, Lesson Plans for Science Methods Reflective Essays, 12/14).

Between when he and his partner originally wrote the three lessons they used in their science methods class and the construction of his Science Methods Reflective Essays, Luke expanded his interpretation of what contributes to a teacher’s reflective thinking, as well. At first he was focused on mainly assessing what students knew (MACS Lesson #3, 11/2), but by the time he wrote his Science Methods Reflective Essays he shifted to addressing the ability to adjust one’s teaching in response to student discussion and responses. This shows that although Luke might have been having difficulty creating the classroom setting he felt was ideal, he was trying to find ways to reflect on this ideal when planning lessons.

*Teaching orientation and noticing ability at the end of the study.* During his exit interview, I asked Luke to again reflect on his beliefs about teaching and learning. At this time, he was struggling with reconciling his beliefs and the realities of teaching. Much of what he originally said was still true, but the biggest shift, which resulted in an overall drop in his student-centered orientation (Table 7), was around his ideas about instructional decision making. He still mentioned wanting to make his decisions about
what to teach and when to move on based on how much students knew, but he referenced
more concern about standardized testing and district mandated curriculum. This was
enough to slide his overall orientation down from Transitional to Instructive (Luft &
Roehrig, 2007). His concern about management and decision to create a teacher-centered
behavior management plan over student-centered instructional design aligns with this
shift.

By the end of the semester Luke’s ability to notice was fairly unchanged
(moderate), with a focus still on accuracy. However, his ability to identify the meaning
behind what students were saying had increased a bit, as in the case of the student who
drew the connection between bark and cell walls, discussed above. Just as he had done
early on in the semester, during the video response portion of his Exit Interview, Luke
focused on what the teacher was doing and providing explanations for why she asked
what she asked. Luke provided little interpretation around what the students were saying,
aside from an assumption that their responses were constructed because of the questions
the teacher asked. Unsurprisingly, his attention was highly tuned to the classroom
environment. For example, he was amazed by the teacher’s ability to focus on one group
for a long time:

What struck me was how much time the teacher could sit there and spend
with one group, it sounded like there was a lot going on in the background,
but from the teacher’s ease, I’m sure that it was all on task. (Luke, Exit
Interview, 1/9)

It is interesting that he makes an assumption about how “on task” students must have
been and that the teacher is fully aware of what students were doing. This reflects his
insecurity about classroom management, which further substantiates his inclination toward somewhat teacher-centered instruction.

As a final note, Luke’s mentor had a really high opinion of Luke’s ability to question students and his commitment to teaching. Interestingly, throughout her Exit Interview (12/18), Ms. Childs discussed different ways Luke assessed student progress. She liked that he asked open-ended questions. However, she indicated that most of his interpretations about student progress was retrospective. This is unsurprising because Luke was somewhat obsessed with data collection and analysis, but didn’t know yet how to use this information. Instead, his priority was mainly identifying who knew what, not adjusting instruction to meet student needs. And Ms. Childs wasn’t necessarily looking to adapt instruction on the fly. Throughout the semester she attributed an ability to know what students need in terms of instruction to experience, not current information. This aligns to Luke’s own views on the relationship between instruction and learning and his belief that keeping notebooks was the best way to tell what students understood (Exit Interview, 1/9).

Janice

As described in Chapter 4, Janice came to the residency program with a solid history as a mathematics tutor. She began the year with a very Traditional perspective toward teaching and focus on student accuracy (moderate noticing). Her mentor was almost the polar opposite, in terms of instructional beliefs. Ms. Gilmore often felt frustrated by their inability to see eye to eye when it came to using informal assessment
to adapt classroom instruction. Ms. Gilmore admitted this was partially due to her inability to plan far enough ahead. Without plans, she couldn’t easily show Janice how lessons shifted depending upon how students responded in class. She hinted at this throughout the semester, but articulated it very clearly during her Exit Interview:

I’m very disorganized. I don’t have a very strict lesson plan. I don’t have what questions I’m going to ask, everything [anticipated]. I think from her perspective it looks like I’m winging it most all the time, but what happens is, I do have a plan in my head of how it’s going to go. When I’m not getting the responses I want to get, I ask a different question and stuff. (Ms. Gilmore, Exit Interview, 1/9)

Despite these professional differences, Ms. Gilmore and Janice got along very well personally. This may explain why Ms. Gilmore was willing to experiment with new ways to communicate about her goals for and input for Janice.

Finding one’s footing. During the second phase of this study, Janice’s mentor intended to work with Janice on lesson planning by having them co-write lesson plans together (Collaborative Reflection Log, 10/8), but this never really panned out.

Meanwhile, Janice knew of this weakness, but did not fully understand the implications:

I am helping my mentor with her organization and trying to get her to stop procrastinating the lesson planning. I can’t wait to start doing more of the administrative side of teaching. My mentor and I just click so well… I have learned to anticipate what she needs in the classroom and I always want to help. I am constantly asking her if she needs me to do anything. We are in constant communication and I know that I can turn to her with any questions… (Janice, Seminar Blog Entry #3, 10/10)

At this early stage, Janice was planning and implementing the entry tasks for class, which meant she had to know what the previous lesson was about and what needed to be reviewed prior to starting the next lesson. During my first observation of her, she
engaged individual students in the entry task, but neglected to address the rest of the class while the one student worked the problem at the board. The only feedback Janice gave each student at the board were hints about things they appeared to forget while doing the algebra involved, such as negative signs. When asked about this, Janice merely responded that these are the types of errors (“tiny little errors”) are “common errors for kids to make,” which means she looked for these types of errors and not necessarily thinking beyond whether the student was accurately completing the problem on the board. In fact, she ended with the assessment that the student did well because “she brought down everything correctly” (Janice, Post Observation #1, 10/4).

When asked about adjusting lessons, her response mainly involved thinking about this in terms of looking back to look ahead—making changes to the next lesson as a result of how things went that day (Janice, Post Observation #1, 10/4). As the semester progressed, Janice took on more of the teaching responsibilities, particularly through observing one lesson and then teaching the next. Through this process, Janice was able to receive feedback from her mentor through in-the-moment responses where her mentor chimed in, follow-up discussion, and written feedback in the form of a digital commentary.

*Learning by doing.* No matter what feedback she was receiving, though, Janice had a particular teaching belief that she had a hard time shaking. In the mathematics methods course, their professor often discussed the value of working the long way through problems so students could discover algorithms and understand the reasoning
behind the algorithm. For example, on one particular day in late October (Phase 3), Janice was still insisting that doing things the long way looked more confusing and students would have a hard time keeping up (Math Methods Observation, 10/26). The professor was adamant that:

If you do it right, teaching why things happen or work is better. Some kids will say, ‘Just tell me how to do it’ but they have been shown many times how and still don’t get it. (Professor, Math Methods Field Notes, 10/26)

Just the day prior, her coach was trying to get her to see how she could use questioning to help students discover the answers to their own questions and walk away from the interaction with a deeper understanding of the content.

As Janice moved through the groups to see what progress they were making, she informed several individual students that incorrect answers had been written. Through our discussion, we talked of ways in which Janice could question and probe the students further about their answers, leading to them understanding that they had not solved problems correctly and why. By asking students to explain their reasoning, they are encouraged to consider why they chose certain answers and will often find their own mistakes through their explanation. (Coach Nan, Formal Observation, 10/25)

The discussion mentioned in the quote above was in response to a really interesting set of interactions between Janice and her students. It took her most of the period to finally get to a point where she shifted from providing facts such as pointing out the slope of a graph rather than asking students to look for patterns and details themselves, to integrating an interactive demonstration to help students visualize the relationship between graphs and word problems (Observation #2, 10/25). When asked what her role was during that lesson, her focus was still on whether or not students had correct answers, but she appeared to realize there was more going on in her interactions.
Our roles at that point in time [are] to instruct, and once we complete the instruction, they’re doing a worksheet, is to walk around and make sure they’re doing it right, and not only make sure that they’re doing it right, but they understand what they’re doing. Maybe, if they got like today, there’s a couple of them who are using the wrong graph. We’re like, ‘Are you sure about that? Rethink that.’… They weren’t getting it. After explaining to them, and I actually, physically, showed them how to do it, they’re like, ‘Now, I get it’… I’m like, ‘Okay, how can I do this where you’ll actually physically see it?’ I’m like, ‘Okay, I’ll just walk. Okay, so I’m starting in a closet, I’m walking towards you, and I’m ending here. Did I go back to the closet? Like, ‘light bulb’. (Janice, Post Observation #2 Interview, 10/25)

Despite this realization and the positive feedback she received for this, she didn’t yet make the leap to using this type of explanation for the entire class and continued to think mostly about how to work with students one-on-one.

During this period of time, Janice was becoming very familiar with students and was able to read their behaviors or work individually with them to address confidence issues. In tutoring mode, she was able to attend to specific student needs such as realizing one boy who, according to her, is usually on top of things, was surprisingly disengaged, so she chose to check in with him (Post Observation #2 Interview, 10/25) and help him get back on track. She also encouraged another student to articulate her opinions about the work they were doing to her group, which was something this student doesn’t usually do. Janice was particularly proud of how this student seemed to glow in reaction to standing up for her ideas (Post Observation #2 Interview, 10/25). However, she was not able to extend her understanding of individual student needs beyond working one-on-one and therefore struggled with engaging the entire class.
This struggle manifested in various forms, but the most frustrating to Janice—enough so that she brought it up as a discussion point during Seminar (10/24)—was couched as classroom management and not content-focused instructional decision making. It was also around this time (shifting to Phase 3) that Janice’s mentor started keeping a digital log of feedback and notes about Janice’s teaching. This feedback also mentioned a lot of classroom management issues, but her suggestions included things to keep students cognitively engaged, even during transitions (Classroom Observation Notes, 11/7-11/8). Therefore, Janice was getting feedback on how to use content to drive management, even if she wasn’t yet putting it into practice. Instead, Janice doubled down on the benefits of having multiple teachers in the room:

We also recently started blended learning two days a week. This is where we work with half of the students in a given class at a time for half of the class period reinforcing the material that we taught the day before. During this time, we normally work on additional critical thinking practice on the material we covered the day before. (Janice, Seminar Blog Entry #4, 10/28)

She also mentioned in the same blog entry that they are using the fact that there are two of them to provide more emotional support and lunch time academic support for students who need it. All these are terrific benefits of having a co-teacher present, but not necessarily contributing to Janice learning how to leverage what she learns from a few students to teach the entire class. Instead, she is just putting out fires. Throughout this semester, she was building strong relationships with individual students, which became more evident as time passed. After my observations ended, it seemed that was awakening to a new way of thinking about the role of a teacher. In a reflection she wrote after her
fifth observation by her coach, Janice admitted to equating helping students get the right answers with being a caring teacher, but this belief was starting to show some cracks:

> I know it is against my nature as a nurturing and caring individual, but the students will not learn if I constantly bail them out. (Janice, Reflection Post Coach Observation #5, 12/5)

This realization was starting to settle in at a point in the semester when Janice and her classmates were being asked to complete a large number of reflective projects. Janice was starting to look at the big picture and pay attention to more than just whether students were right or wrong. She was starting to realize that she must to attend to a many different tasks in order to help students learn. The desire to balance all these roles and still help students seemed to be at odds and she was grappling with multiple challenges.

**Looking ahead to student teaching.** During Phase 4, Janice was starting to realize she would be more on her own in the next semester. This was clear from how she discussed the Child Study she performed for the program Seminar (11/28). She talked about how working with one student made her realize how many different skills are necessary for student success, such as organization and work completion. But she was still using the term “understanding” to refer to accuracy over deep content understanding, which makes it seem as though her reason for wanting students to complete all of their work is less because it is important for practice and more because it is important for showing they can do the assigned work (Janice, Child Study, 11/28).

In addition to being concerned about work completion, Janice was also struggling with time management and lesson planning. It is possible these concerns are all
interrelated as she wanted students to be moving forward while her mentor was out of the classroom for two days, but wasn’t fully ready to consider her role as the teacher beyond assigning something fun to do. This led to some real challenges and her questioning her ability to lead class on her own, despite her peers telling her they had seen a lot of growth when they visited her (Seminar, 12/5). As a result, her mentor and she set some goals for the new year around encouraging her to take more of a lead in terms of classroom management and keep ramping up her lesson planning, with Ms. Gilmore’s support (Collaborative Reflection Log, 12/17).

Reflecting on lessons learned. When asked to reflect on the previous semester, Janice and Ms. Gilmore had some different perspectives on Janice’s abilities and needs going forward. Janice was still very much of the mind that learning means being able to complete work accurately and be able to explain to others how to complete the work, so her own goals were more focused on managing class as a series of well-planned activities. Ms. Gilmore was acutely aware of this, but held out hope that Janice could still learn to question students and allow students to guide their own learning more (Ms. Gilmore, Exit Interview, 1/9). Ms. Gilmore just wasn’t sure how to help Janice make this transition and kept blaming herself for not doing a good job of modeling lesson planning and using student ideas in the moment. Ms. Gilmore also believed that Janice didn’t feel “comfortable being uncomfortable,” even though being a teacher means examining the moment you are in and “being curious as to what’s going on,” much like a scientist (Ms. Gilmore, Exit Interview, 1/9).
At the same time, Janice started to realize there was some method to the madness around her. During her exit interview, she specifically pointed out how she appreciated when students had opportunities to identify mathematical patterns on their own. She attributed this to her mentor teacher, but it was also a point of discussion throughout her math methods course. It seems as though something happened between when I interviewed her at the end of November and when I held her exit interview at the end of December that made her start to realize students need to be cognitively engaged in the classwork. Based on her end of semester reflections for her methods classes, she was still uncertain about what exactly constitutes active learning and was satisfied if students did the work:

In all three lessons our students were active participants in their own learning experience. In all three lessons the students used everyday objects to model the phenomena that we were studying. In two of the three lessons, they watched a video and actively took notes. They then had to use those notes to correct the models they had previously been working with to incorporate the new information that they had gathered form the video. Throughout all three lessons we encouraged the students to ask questions and respond to the questions that we posed. There were no wrong answers or stupid questions (Janice, Science Methods Reflective Essays, 12/22).

The only aspect of what she describes as active learning that matches what she was being taught all semester was the part about “incorporate[ing] the new information” into their prior models (Janice, Science Methods Reflective Essays, 12/14). Once I looked at her lesson plan, though, it was clear there were few opportunities for students to explain their thinking or question their ideas except while moving physical models around. Every question they were asked, including the guided notes they were given and
the exit ticket they completed, were focused on factual information that do not require much, if any, conceptual understanding of the material, just that they listen and were able to repeat back vocabulary or definitions.

_Teaching orientation and noticing ability at the end of the study._ In the end, Janice was still undergoing a lot of change. Of the six primary participants, she made the biggest change toward being a more student-centered teacher (she ended the semester as an _Instructive_ teacher; Table 7; Luft & Roehrig, 2007), but still had a way to go. When she observed others teaching, whether they were her mentor (Janice, Observation of Mentor, 11/28) or the teacher in the video I used during her Exit Interview (12/27), she was still primarily focused on what the teacher was doing and other concrete aspects of the lesson. She did very little to interpret what students were saying beyond whether they were correct. She generally interpreted student participation as evidence of understanding. However, she was working on using examples of student work, such as homework and material turned in during class, to make decisions about what to teach next, which is a step in the direction of more advanced (high) noticing skills, just not yet “in-the-moment.”

_Anthony_

Like Janice, Anthony is a mathematics specialist at MASD East. Anthony and his mentor, Mrs. Hartman, co-taught sixth grade mathematics. As described in Chapter 4, Anthony started the year with a positive outlook, but his teaching orientation was somewhat teacher-centered and his ability to attend to what students were doing in class
was quite rudimentary (I rated him as *Instructive/Transitional* with a low noticing ability; Table 7; Luft & Roehrig, 2007). An important contextual aspect of Anthony’s experience was that he and his mentor had an uneasy relationship. They had different communication styles and Anthony’s lack of self-confidence sometimes translated into a hesitation to act. This became more of an issue toward the middle of my study, as will be discussed below.

*Finding one’s footing.* Given Anthony’s tendency to consider how students feel in class and their specific behaviors, whether academic or not, I was unsurprised by most of what I was able to see during Observation #1. For this lesson, Anthony was using the pre-existing mathematics curriculum’s entry task for the day, but he added his own twist to the discussion, thus taking ownership of it. The problem was an introduction to negative numbers using a bank account as a context. Anthony opened the lesson asking students, “Who here likes money?”, which immediately attracted the attention of every student in the class. As he noted during the Post Observation #1 Interview, this attention included a student who is often absent and rarely says much other than to ask if she can use the bathroom (Observation #1 Field Notes and Interview, 10/4).

During this introduction to the day’s lesson, Anthony used the discussion about the balance of the example bank account being -$30 to identify what types of language the students used to discuss money. He tried to keep a list of terms students were using up on the board (e.g. “owe”, “debt”, “withdraw”, “take out”, etc.) and kept the discussion fairly conversational. He used a vertical number line to help students visualize the numbers. He did not explicitly ask the “reasoning” question posed by the curriculum
(“What does a balance of $0 mean?”), but did address this somewhat by asking students what a “0” meant in this context, asking them, “Do they have any money?” (Observation #1 Field Notes, 10/4). Then he passed this lesson off to his mentor, Mrs. Hartman.

During my interview with Anthony, he admitted he had not gotten to the entire point of the problem. He indicated he had read the curriculum guide and planned out generally what he was going to say, even running over it in his mind ahead of time. Since his coach and I observed him toward the end of the day, he also already had multiple opportunities to practice this mini-lesson. This is important because he ended up likening the experience to being an actor:

I prepare for [lessons], like let’s say, as I go over it in my head, like how I want it to go. And then you can, you know, it’s not improv but it kind of sort of [is] if you have a plan, right? And then you kind of go off that. Today, though, I feel like I did not go over in my head enough. I didn’t do like my vision long enough to do like the second problem. (Anthony, Post Observation #1 Interview, 10/4)

When asked what he would do differently in the future, he said that he would try to identify and focus on the specific mathematical concept and related questions he wants to cover. He felt he got distracted by keeping track of the vocabulary and then was making decisions that were not necessarily in the best interest of supporting student understanding of negative numbers in the future. For example, he accurately recalled that he asked students if negative 30 was bigger or smaller than negative 40. This may be one way to view negative numbers, but he was conscious of the fact that his mentor is very precise in her language choice and would likely have said something like which is more
negative. This shows that his mentor tries to explain the reasoning behind her choices and he was trying his best to follow her lead and enact them faithfully.

Similarly, Anthony was also learning to think about what it means to understand mathematics. When asked how he could figure out what students understood about negative numbers, he explained the importance of asking the right type of question:

If you’re asking them questions in which they get an answer, such as, ‘Oh, it’s negative five.’ Or thinking [of an] actual numerical answer, ‘cause I’m the same way, but children are very like, ‘This is the right answer.’… I feel like you don’t get as much… I don’t learn as much about their thinking [with] the numerical answer. So the answer to your question, how do I know that they’re learning or they understand something? It’s asking them a concept question. So those questions earlier that I did forget of like, ‘What would you need to do to make this a negative balance?’ Then it’s less about the correct number but more about them processing and thinking, ‘I want you to do the following, make a withdrawal.’ (Anthony, Post Observation #1 Interview, 10/4)

This is a big step up from where he was even during Phase 1, where he was more concerned about student behaviors. By being put into the position of leading class and trying to live up to the expectations of his mentor, he was forced to think about more than just what it means to give an answer, but what this answer tells you about where students are in their understanding.

During this time, he was also appreciating a lot of what he was learning in his classes at the university, especially the math methods course. He referenced concepts such as “productive struggle” and the value of using manipulatives when exploring abstract concepts (Post Observation #1 Interview, 10/4). Even his mentor acknowledged that he was starting to show an awareness of the complex nature of being a teacher and
balancing all of the different roles and requirements (Observation #2 Debrief, 10/4). She appreciated that he was trying to be well prepared for class, but was concerned he was over-preparing. These different tensions became a major point of contention during the rest of Phase 2.

Just after my first observation of Anthony in his residency classroom setting, he had a falling out with his teaching partner for both methods classes. He was not contributing equally to the work, and his partner was very upset with him. He arrived ill prepared to their first teaching session, and was critical without being constructive or helpful. As I observed him more, I began to realize he seemed to feel over his head and uncertain about how to balance the demands of the program. Eventually this led to an intervention from the program coordinator, who stepped in just before I observed him a second time, later in October. This led to a dramatic shift in Anthony’s affect, where prior to this he was inquisitive and engaged in our conversations, now he was more pensive and detached. This series of events had an impact on the information I was able to gather from him and what meaning can be drawn from what was being said.

I knew Anthony was aware of letting down his partner because he admitted he was unprepared both orally to me during class time, but also in his reflection of his first science methods field experience (Anthony, Science Methods Lesson #1 Reflection, 10/6). His reflection was mainly about how students behaved, but he mentioned that students had difficulty understanding the relationship between the interactive forced perspective examples they explored and a solar eclipse. Some of this he attributed to their
lack of mathematical content knowledge about ratios, but that was the extent of his discussion of their understanding of the material. Instead, he explained that he had been unprepared and therefore unable to respond to off task behaviors.

It is difficult to separate Anthony’s lack of preparation from his lower confidence with the content in science, however, he had a similar experience in the math methods field experience the next period, which led to a major argument between him and his partner. I think this was an important learning experience for Anthony, and after our discussion the day before at his residency placement, being prepared and able to interact comfortably about the topic at hand were foremost on his mind. Being as reflective as he was, yet hesitant to take leaps of faith, it would not surprise me if his lack of participation in methods was, to some extent, a knee jerk reaction to feeling a lot of pressure and not being able to find a way to balance all of these demands on his own.

*Learning by doing.* Despite the discomfort Anthony may have been feeling, the conversation held between his coach, his mentor, him, and me after my second observation of him was really interesting. His mentor listened carefully to our entire conversation, jumping in periodically to either clarify the reasoning behind some of the decisions made in class or to investigate Anthony’s responses more deeply. I was under the impression that she talks to him about these types of issues a lot, which provides him a lot of access to the deep, reflective thinking needed to engage in noticing.

The most interesting interaction I observed was when Mrs. Hartman honed in on something Anthony said about multiplication and exponents. She was concerned he was
accidentally misleading students about using the term “double” when referring to exponents:

Mrs. Hartman: I just wasn’t sure if they were getting mistaken because the base was two that it was doubling. That isn’t always the case with exponents. You said they were adding earlier. I wasn’t sure if that was kind of a misconception that was happening because the base is two, and ultimately, with each additional exponent, the evaluate- the solution does double. When we talk about exponential growth when the base is something different, it’s not going to be that pattern.

Anthony: I do think you’re speaking something that I should be aware of because I think a lot of them did have the pattern of like day one is going to be this, so by day 17 it’s going to be my 17th exponent, and that may not be necessarily true, too.

Mrs. Hartman: Yes. I was more thinking of when you had alluded to earlier, someone doubled their solution or coins or that day. I don’t want them to. I would not want them to create a understanding as if that’s what exponents are. (Post Observation #2 Interview, 10/23)

This interaction shows how very specific Mrs. Hartman is when it comes to language use and paying attention to not only what students say, but what they mean by what they say. It is a fantastic example of good modeling of what it means to pay attention to student thinking and I am sure if she had been interacting with the student they were referring to, she would have addressed this issue head on and in-the-moment. Anthony then tried to explain that he hadn’t thought of it quite this way, but had worked with one student to explore the use of repeated addition to build up to repeated multiplication, which he thought might help offset this potential misunderstanding about the relationship between the base and the exponent. To this, his mentor explained she was concerned about
looking at the patterns used in this specific example, which was a base two problem, and the potential misconceptions the students might draw:

It was more when you had mentioned like you were saying patterns as well as doubling. I just wanted to clarify and make sure that it wasn’t a pattern as the total number of points per day doubles as opposed to kind of the exponent, yes. (Mrs. Hartman, Post Observation #2 Interview, 10/23)

It was clear from the rest of this conversation that Anthony and Mrs. Hartman had discussed some of the potential misconceptions with students openly, especially the inclination to immediately multiply the base by the exponent. What I was struck by was the tension I sensed between Mrs. Hartman and Anthony. She was interjecting a lot more than she had at the previous debrief, but also was sitting pretty stiffly while she listened. It could be I was paying extra attention to their interactions because I knew the program coordinator had been to meet with them together earlier that same week, plus Anthony had expressly requested we not begin our discussion until his mentor could join us. Regardless of why I was paying attention to this, I think it was a significant interaction and possibly explained why Anthony answered many of the remaining questions looking toward her and very carefully choosing his words.

Further to the point that there was tension present, when Anthony and his mentor completed their Collaborative learning log, they purposefully left the “What’s Working” section blank. Then they listed a series of suggestions that harkened back to early in the year, indicating Anthony needed to sort of reset (e.g., familiarize himself with names and plan the entry task earlier in order to discuss it with his mentor). Despite these setbacks, Anthony continued to reflect on his experience and started stepping up in his methods
classes more. Toward the end of Phase 3, Anthony and his mentor were still focusing his goals on learning student names, but added a little about making sure he had a more complete understanding of each upcoming lesson beyond the required, bare-bones lesson plans his mentor wrote for the school’s administration (Collaborative Reflection Log, 11/6).

*Looking ahead to student teaching.* During Phase 4, Anthony continued to struggle with tying together all the different pieces of teaching mathematics to sixth graders, but he appeared to be doing more thinking about how students think about math. During our interview after Observation #3, Anthony pointed out that he was starting to realize how much more complicated teaching and learning mathematics is:

> It’s funny because I felt like when I first saw this lesson when you told me three weeks ago, I was like, “This is going to be like so easy.” All you do is combine terms, right?... This is actually, I think, something like a more challenging in the sense of—I think once you get it, it’s cool, like getting them to the point of understanding. We’ve had this on the board the 2n+5 but they’re coefficient and variable and constant for a while. Getting them to understand that and how it all works together, it actually does take a lot of—just like talking and explaining and using your words and then you have that moment, was like, ‘Oh, okay.’ (Anthony, Post Observation #3 Interview, 11/20)

Throughout the interview Anthony referenced the importance of experience in preparation of learning what types of misconceptions students might have.

> You know what I think this is? I think this is all experience stuff… I think like, ‘Hey, here’s my question. Then here’s my other question.’ Obviously, they’re going to do my first question. They’re going to do my second question, but I’m learning through this experience, that’s not how they think… (Anthony, Post Observation #3 Interview, 11/20)
His mentor, however, pushed him to think more about what he is learning about student thinking in the moment. She was concerned that following our previous meeting Anthony was over-scripting lessons and not doing enough “organic” teaching. She wanted him to pay attention to what students were doing and saying so he could adjust instruction accordingly. Evidently, this had been a point of discussion quite a bit recently, as she was having him lead the same parts of the lesson multiple times throughout the day:

I think one of the conversations Anthony and I are having more and more frequently [is being] the teacher is more of pulling the learning out of the students, as opposed to giving them the information. That’s something that he’s been working on more and more lately. I do believe my experience has shown that this objective or standard is even more so challenging because kids are looking for an answer, not recognizing that the expression is the correct solution… Even getting to where he was in [sixth period] for our kids emphasizing the geometry part of it, I think that was really valuable… Because in sixth grade, we still get kids that don’t know these things. I really appreciated those parts of it. I think not giving the value for the variable is where they’re really going to hone in on the understanding of algebraic expressions combining like terms. I got to see Anthony do this four times. To say that he showed progress and make great improvements with each one I think is fair for sure. (Mrs. Hartman, Post Observation #3 Interview, 11/20)

Based on this conversation, Anthony was starting to be able to reflect between lessons, which is a related skill to noticing. With practice, this can lead to adjustments made on the fly. Anthony was appreciative of the compliment from his mentor, and then went on to say that he is trying to improve, but it is a lot “to keep track of… It’s like you know what you’re saying, but sometimes you don’t…” (Anthony, Post Observation #3
Interview, 11/20). Going forward from here, Anthony and Mrs. Hartman were supported by his coach:

Anthony is encouraged to continue thinking about the contributing factors to students’ understanding or lack thereof. While being able to identify areas that students were not successful, he would benefit from being able to consider the reasons for this, using what he knows about student thinking. Being able to identify the reasoning or factors for students’ misunderstanding will better equip him to consider taking different approaches to teaching these and similar skills in the future. (Coach Nan, Formal Observation, 11/20)

Reflecting on lessons learned. This push toward thinking more deeply about why students were giving the responses they were giving translated somewhat to how Anthony reflected on his experience teaching mathematics for his methods course. There he still was focused on using information between lessons, but at least he was thinking about how valuable the interplay between student and teacher is (Anthony, Math Methods Reflective Essays, 12/14). This mindset of using data between classes was also mentioned by his mentor during our Exit Interview (12/18), where she said that she had been working with him to anticipate student responses, but he was still focusing more on his teaching rather than student learning. It was clear that student learning was very important to her, because she described the tension she feels between mentoring Anthony and making sure their students are well served:

This may be wrong to say, but like I still have to make sure that, though I want Anthony to have the richest experience he can here, I also have my obligation to my students learning, so I have to balance the two. (Mrs. Hartman, Exit Interview, 12/18)
While his mentor was concerned primarily about what students are learning and their academic success, Anthony was thinking more about who his students were becoming. During our Exit Interview, Anthony returned to the themes he was concerned about at the start of this study: concern about being a role model and helping students develop good academic skills. From this perspective, Anthony and his mentor were almost always speaking across purposes. This bears out in how he talks about how he knows if students understand material, as well.

Teaching orientation and noticing ability at the end of the study. Whether Anthony was observing an unfamiliar teacher, such as during the video portion of our Exit Interview, or talking about his own students, he focused a great deal of his attention on the affect of students. He was looking for the emotion and physical ways students respond—are they reacting quickly and with confidence or “hesitating” or “fumbling” (Anthony, Exit Interview, 1/9). Because Anthony was so concerned about how students feel about mathematics and being in the classroom, his teaching beliefs hadn’t changed (still Instructive/Transitional; Table 7; Luft & Roehrig, 2007). However, he was starting to learn to shift his attention toward the content of what students were discussing and not merely their non-academic behaviors. In this way, his noticing skills were more moderate, even with his mentor pushing for him to be more responsive to students in the moment.
Jason

The last of the MASD East resident’s experience throughout the semester was almost as complicated as Anthony’s. Jason and Mr. Waters also did not always see eye to eye, which may have complicated their working relationship and affected Jason’s trajectory. Jason began the year with a vision of being a Responsive educator who elicits student ideas and guides them as they make sense of their own learning. However, the substance of what he thought this would involve mainly revolved around his role as an instructor who sets the expectations and learning experiences. This made his overall teaching orientation more Transitional than Responsive (Table 7; Luft & Roehrig, 2007).

His mentor, Mr. Waters, was fairly traditional in that he was very much the head of the classroom, which possibly made it difficult for Jason to find his footing. For example, Mr. Waters relies heavily on tasks that are copied from books and do not involve giving students a chance to share their ideas or explanations with one another. Everything about their classroom made science seem linear and static, even down to the “Think Like A Scientist” board by the door focused on experiments rather than the construction of scientific concepts (Observation #3 Field Notes, 11/13). Given the program’s expectation that residents incorporate more student-centered pedagogy aligned to the expectations of the Next Generation Science Standards (NGSS Lead States, 2013) and incorporate 5E lesson plan designs (Bybee et al., 2006), Jason had an uphill battle ahead of him.
Finding one’s footing. In order to observe Jason when his coach was also scheduled to observe him, it was usually during one of the social studies classes. Although he would need to be certified to teach all subject areas if he accepted a fourth, fifth, or even sixth grade position, Jason did not initially engage with the planning of social studies. Instead, he stood back and assisted his mentor, mainly helping deal with behaviors one-on-one. Because he hadn’t put a lot of thought into the first lesson I observed, he wasn’t prepared to respond to questions about planning or different ways to assist students during class. Despite his unfamiliarity with the material, when asked about what he would have done differently to help students learn about mapping and geography, Jason provided a description of a more student-centered lesson that would have given students more ownership over what they were learning (Post Observation #1 Interview, 10/4). This suggests his teaching orientation is truly student-centered, and provided hope that going forward he would be working hard to incorporate more pedagogical choices that elicit student ideas and use these to direct the course of his classes. I hoped we would see more of this tendency become clear as the semester progressed, especially as he became more confident with the material and working in front of a classroom.

In terms of content, given the program Jason was part of and the expectations of the middle grades certification process, I was surprised by his hesitancy to dive into learning more about teaching social studies. When asked about being more involved in
the planning of all classes, including social studies, he said he felt his mentor was setting the pace:

We’ve been, I guess, struggling a little bit with that recently but we did make it a point to say that today we want him to stay after so we can talk about what we’re going to be doing in the lesson plans. But then, with the social studies, I think he’s been kind of excluding me a little bit just because that’s not why I’m there. But that’s just as far as like the two-week plan goes like I still, I [kind of know] what we’re going to be doing like pretty much the day of. With science, I know what we’re going to be doing for the next couple of days but for social studies, it’s usually a day of is when I know. And I think sometimes, at this point, I think sometimes, even Mr. Waters doesn’t know exactly what he’s going to do until the day of. (Jason, Post Observation #1 Interview, 10/4)

Similar to several of his peers, Jason mentioned that his mentor doesn’t appear to plan ahead and this is a hinderance to his being able to engage more in the classroom activities. This lack of visible pre-planning on his mentor’s part resulted in Jason losing out on early opportunities to see how curricula are arranged and modified, while also preventing him from engaging students in productive discussion during class. As it seemed his nature to try to be as helpful as possible, he still engaged with students around content when he was comfortable. For example, Jason spent some time trying to assist a student who didn’t understand how to use the information from the textbook to complete their assignment. He took time to give some explanations of the content that was relevant (which happened to be scientific in nature—crop needs and energy sources) (Observation #1 Field Notes, 10/4). However, his being ill prepared resulted in his not being particularly useful to the students and may have contributed to the increase in chaos the minute his mentor stepped out of the room. As his coach reflected after our observation:
Jason’s knowledge of objectives, relevant curriculum and lesson planning are additional areas that require more effort and attention. Jason demonstrated and communicated to a student that he had not previously seen the homework assignment. He is encouraged to consider students’ perceptions of his content knowledge if he continues to directly communicate his lack of awareness… Jason is encouraged to take a larger role in familiarizing himself with the curriculum that is being taught, and as he did communicate that his mentor teacher shares lesson plans with him before each week, he should develop a plan to review and familiarize himself with the content so he is fully aware of the concepts students will be learning and the objectives… Both student/teacher relationships (mutual respect, rapport) and content (knowledge of objectives, goals, and future direction) are crucial components to being an effective teacher and ensuring students meet success in school. (Coach Nan, Formal Observation, 10/4)

Despite not being fully equal early on, Jason was developing strong interpersonal relationships with students that allowed him to assist with classroom management on a small scale. It was during my first Observation Interview that Jason expressed a desire to improve his engagement with the full class. His coach supported this goal and suggested he would be able to be more involved if he is more familiar with the material being covered. Jason officially made adding more face time in front of the full class a goal (Collaborative Reflection Log, 10/11).

As Jason wasn’t fully engaged in planning and implementing class material in his residency placement, it is unsurprising that he found his first teaching experience in his methods class to be less than desirable. He admitted he had a tendency to do a little bit of the explaining rather than opening the door to student-driven responses, but periodically provided opportunities for students to share their insights. He felt this was hampered, to some extent, by difficulties with pacing (Jason, Post Science Methods Lesson #1 Reflection, 10/6). It makes sense that he found the first time he was responsible for
writing and implementing a full lesson to students he had never met before to be challenging. As the science specialist to his partner’s math specialist, he laid the foundation for the mini-unit they decided to plan and teach. Based on my observation that he is nervous speaking in front of even his more familiar residency classes, it is reasonable to infer his nerves limited his ability to stick to his plan and maintain a student-centered lesson.

As mentioned in Chapter 4, Jason’s early teaching orientation was built around a belief that students need to be partners in their learning and that his role as a teacher is to encourage students to try and learn from their mistakes. This was evident even a month into his residency placement. Sometimes, in his classroom, he commented on how he liked that “we have different answers here,” which indicates to the students that trying is of value (Observation #1 Field Notes, 10/4). He mentioned in multiple university courses that he felt this approach was making an impact because students are starting to turn in more completed homework than they did before (Post Observation #1 Interview, 10/4; University Course Field Notes, various).

It is interesting to note that because he wanted students to feel comfortable and safe in his class, he kept mental tabs on who was trying or not and made a point of checking in on students in this order: those who were physical distractions, those who often were a little slower at understanding the material or purpose, and then those who often were quiet but had blank pages even after several minutes have passed (Jason, Post Observation #1 Interview, 10/4). This pattern of noticing aligns with a more low skill
level, but shows he includes some look at completeness of work to be important and therefore he is approaching a moderate noticing ability level. It makes sense that he pays attention to the misbehaviors first. But the fact that this appeared to attract most of his attention may have kept him from progressing further and paying more attention to content knowledge and understanding—two things he articulated as important. Seeing as his role in Mr. Waters’ class was more as an assistant than an equal, he might have been only able to practice behavior-focused responses and therefore wasn’t developing these other skills.

*Learning by doing.* As the semester wore on, Jason had another setback in his methods class when his partner took the lead for the second science lesson, but was significantly late to class. Evidently Jason was so poorly prepared he had their entire group join another group’s lesson until his partner arrived (Jason, Science Methods Lesson #2 Reflection, 10/21). Additionally, the day before my second observation, Jason had another wakeup call relating to being prepared. His mentor was out without warning and Jason had a hard time controlling the classroom, even with (or possibly despite) a substitute present. This seemed to make it obvious to him that he needed to be more involved in all stages of planning. Jason had started to become more involved in planning and was starting to reflect on how this experience might translate into his teaching on his own the following year and beyond:

One of the bigger things that I’ve been thinking about recently is it’s going to be a totally different experience when I’m in my own classroom. As much as I am their teacher right now, I’m not, Mr. Waters is their teacher. I’m the teacher resident. It’s like a difficult thing for me to… I don’t know, think
about, because it’s like I want to be their teacher and I am their teacher, but I’m not. They know it, every everybody knows it, the principal knows it, Mr. Waters, everybody knows. Even though Mr. Waters, he’s done a phenomenal job in trying to keep me represented and keep me respected on the same level in everything, but I’m not here on Fridays, I leave early on Wednesday, I’m not their teacher. (Jason, Post Observation #2 Interview, 10/25)

Jason’s frustration with how the semester was going was also leading him to consider other ways he and his mentor are different and how this possibly impacts not only his success as a teacher, but also the success of his students:

I think he’s great, but [Mr. Waters] has his objectives on the board because he was told that he had to because of the superintendent would be walking around. In my classroom, I would want to have the objectives on the board. He doesn’t see the purpose for the kids to have an objective on a board. I think there is a purpose to that. I think it’s important that kids know and also even like, ‘Yes, he’s got some rules up there.’ I would want to have pretty explicit rules that the kids can all very easily see, that they’re all very aware of that all times, so that I can almost just point to. I just feel that would help with my own classroom management and just my own personality. (Jason, Post Observation #2 Interview, 10/25)

At this stage, he was acutely aware of some deficiencies, but still respected his mentor and felt they had a good working relationship. These differences in opinion may have been propelling Jason forward into thinking about many different aspects of teaching and learning.

At this point in time, Jason was also becoming more capable of discussing what students understood about the content being covered. In his residency experience, he was doing more grading and becoming more familiar with patterns of misconceptions and wanting to find ways to communicate with students about these ideas (Post Observation #2 Interview, 10/25). But he also carried this idea into his reflection about his final
Science Methods Field Experience. While reviewing student explanations of the phases of the Moon, he took some time to consider whether the responses indicated a good understanding of the material covered, and then the implication this has for his teaching:

Both of these show a possible understanding of what we talked about, but it is not clear understanding. This means there was not enough checking for understanding throughout the lesson. Another weakness was that students were not engaging in the discussion as much as we would like to see. There could have been clearer instructions and expectations for what we wanted them to do. (Jason, Science Methods Lesson #3 Reflection, 11/2)

The fact that Jason identified engaging students in more formative assessment and active discussion as being things he could have done more of indicates he already was starting to look for opportunities to engage in this process. This aligns with his generally Responsive-leaning teaching orientation, but also shows he is starting to be aware of pieces of noticing that are important foundational pieces of creating a responsive classroom.

*Looking ahead to student teaching.* During our final joint observation, Jason’s coach and I were able to sit in on a more typical science class. We had already seen two social studies classes, which tended to be textbook-focused and not very engaging for students. It turns out their science classes were much the same, even despite being given a new curriculum that is supposed to be more aligned to the Next Generation Science Standards (NGSS Lead States, 2013) than the old curriculum. In this particular case, students were looking up facts online about specific locations around the world in order to learn more about climates. Throughout class, Jason moved from student to student, checking on their progress and answering questions. Even though Jason was taking the
lead in planning and teaching the science classes, it appeared to me that was essentially
teaching the same way his mentor does.

Jason’s coach was concerned that he wasn’t engaging students in their own
learning enough. She discussed with him the value of having students sharing their
explanations of content and engaging cognitively with the content. The coach was
concerned that by being as task-oriented as Mr. Waters was, they were missing out on
opportunities to have students probe deeper and exploring beyond the what of the content
and more of the why of the content (Post Observation #3 Interview, 11/13). Jason
appeared to understand what she meant, and provided some explanations for why the
class worked out as it did:

[Mr. Waters] has been so used to just doing direct instruction and the
students are very used to receiving direct instruction that it’s been such a
struggle to even try and get them to think for themselves because so many
of them just want to be right. That’s it. That’s what’s important.

Our society has placed so much value on being right that kids, if they’re
not—Even that girl today, in the back of the classroom, she asked me about
the one question and I brought her to one of the websites where it has the
answer. I basically showed her the answer and she’s like, ‘Was that the right
answer?’ I laughed a little bit because I’m just like, ‘How bad is our society
that I can show you the right answer and you still need to know that that’s
the right answer?’ (Jason, Post Observation #3 Interview, 11/13)

Here Jason rationalized the lack of cognitive engagement of students as being
purely the result of years of experience being spoon-fed material. Later, he describes
another student who found a good resource for information on his own, but neglected to
copy the material down. Instead that student moved on to a different website. Jason was
flabbergasted, and then went on to explain that he tries to “lead with questions,” but it is difficult when he has so many diverse learners in his class:

Most of them I feel I try and lead with questions, but then some of them they’re on very different levels. We’ve got kids from second-grade reading levels to tenth-grade reading levels in the same class. The kid with the second-grade reading levels is not going to be able to research the same way as the kid that’s on his reading level. (Jason, Post Observation #3 Interview, 11/13)

In all of these cases, Jason was looking for reasons why their teaching was not working out, but he doesn’t effectively consider his own role. As his coach pointed out in her Formal Observation, Jason was comfortable discussing teaching strategies but struggled to identify his own strengths and weaknesses:

He is, however, encouraged to reflect upon his own practice and the effectiveness of the strategies utilized in his lessons. Jason frequently communicates a lack of awareness as to how he could have approached lessons or aspects of lessons differently and does not communicate his awareness regarding practices that did not produce desirable outcomes. Similarly, Jason is encouraged to consider student learning and theory, connecting his practices to his students’ achievement. When working with individual students who demonstrate a lack of understanding, consider why he/she may be struggling and what you can do to facilitate a deeper understanding. (Coach Nan, Formal Observation, 11/13)

Reflecting on lessons learned. Around the same time as my final observation of him, Jason was tracking and working closely with a student for his Seminar course’s Child Study assignment. After working so closely with a student of his choosing (called “Joe”), Jason came to some conclusions about motivation that seemed to reinforce his belief that students need differentiation, almost to the point of individualized attention. He then draws the connection between having to constantly remind his one student to
focus and the broader idea that all students need to be encouraged to keep trying. It is an interesting jump in logic that I feel reveals a lot about how Jason, and his mentor, approached motivation and learning in their classroom:

What stood out the most working with students in 6th grade was that most of them are afraid to try. My mentor teacher and I noticed this from the beginning of the school year and our classroom mantra became ‘it is more important to try than to be right.’ Differentiating for some students was more difficult. We did not know exactly what they needed to succeed if they never put any effort into the assignments in front of them. I might not know exactly what Joe needs to increase his motivation yet, but I will keep trying to find ways to help him and the rest of my students. (Jason, Child Study, 11/28)

By connecting differentiation and motivation, he is acknowledging that every student has their own reasons for learning and these need to be tapped into, but he also admits that the teacher has a role in this. It is unclear whether this role is to individually motivate every student or create engaging lesson plans that connect with all students. Additionally, it is unclear what role cognitive engagement will have in developing these motivational lessons. In Jason’s Reflective Essays (12/14) for his science methods class’s final, he briefly connected active learning to the experience of students discussing concepts and evaluating ideas, but the majority of his essay focused on hands on activities that build situational interest. However, he never explains the explicit connection between engaging in activities and learning. Given the fact that Jason has said his mentor tends to teach through direct instruction, it is unsurprising that Jason is getting little opportunity to see how responsive teaching can work. He, instead, grasps on to the periodic pedagogical
activities he personally connects to, such as telling students, “It is more important to try than to be right.”

At his final first semester observation by his coach, Jason implemented several effective management tools to increase participation and engagement, such as using popsicle sticks to select students to call upon, using a timer to enforce time limits and improve pacing, asking a wide variety of students their perspectives, and asking good questions to get students to think about why a phenomenon occurs (Coach Nan, Formal Observation, 12/6). The shift in how Jason was engaging students reflects his learning from feedback, but also possibly his awareness of how quickly his full-time student teaching experience was approaching. Based on my Exit Interview with his mentor, it sounded as though Jason was trying to do more to act upon his beliefs about teaching and learning, despite what he may have been observing in the classroom.

Mr. Waters had a different view of his own teaching than what I observed and what Jason had commented on throughout the semester. Mr. Waters saw himself as good at listening to students and adjusting his lesson accordingly. He may have done this to some extent, but his teaching was still very teacher-centered. This came through a little bit when talking to Mr. Waters—he acknowledged that he is the one who does the explaining to students, and therefore is the one in control of knowledge in his classroom. This was clear when Mr. Waters was asked about Jason’s ability to elicit student thinking. Interestingly, he started to reflect upon his own role in modeling for or explaining to Jason:
Right away, he was using questioning techniques and leading techniques that he clearly was learning in [university-based] class. There’s just something about the way he was talking to kids, I’m like, ‘You learned that from someone else, you didn’t learn that from me’… We’ve been working on that when he leads a lesson, when he’s trying to get kids to answer questions, and participate in discussion. He’s definitely thinking about, ‘How does it relate to the topic?’ and, ‘Are they showing mastery?’ There’s definitely still room for improvement. As I’m watching him do the same thing, I’m realizing I also have some room for improvement and, in the areas where I don’t, the reason I’m good at all is actually because it’s just the way I think. It’s one of my natural talents, as a teacher, I’ve always tried to put—‘How’s this person thinking and how does that relate to what I’m trying to explain to them?’ Then, if I need to, then reexplain it in a different way for them. (Mr. Waters, Exit Interview, 12/18)

In this reflection, Mr. Waters says he is good at reading students and responding accordingly, but just not good at explaining his rationale to Jason. He does have some strong points, though, such as wanting Jason to keep in mind the big picture of the lesson, so he can adapt his instruction. I think this is a valuable insight, and could very well be adapted by a preservice teacher to apply to a more student-centered pedagogical choice.

Mr. Waters also acknowledged this fundamental difference between the two, wherein he felt Jason’s expectations for students were unrealistic where Jason had “very high standards and [didn’t] just want them to memorize facts” (Mr. Waters, Exit interview, 12/18). Throughout this interview Mr. Waters references himself as an idealized example of a teacher (“the reason I’m good at all is actually because it’s just the way I think. It’s one of my natural talents, as a teacher”), which suggests he has been trying to get Jason to emulate his teaching and expectations. This is noteworthy as it also provides some context to the frustration Jason shows when thinking about what students are capable of doing or actually are doing in class. For example, in his Intake Interview (9/14) he
expresses surprise as what the students in the video were doing, even though they were approximately the same age as his students. Additionally, he spends a great deal of time reflecting on the social influences or reasons for why students tend to only want to provide answers if they know they are correct. For example, on 10/4 he discusses the issue of students being used to being “spoon fed” information and not being willing to look for information on their own. This sentiment is echoed on 11/13, while reflecting on the how students spent most of the period asking him if they had found the right information or simply stopping their work every time they hit an obstacle. These suggest Jason is very reflective, but he struggles with making connections between how his students behave academically and how to respond to them.

*Teaching orientation and noticing ability at the end of the semester.* I mentioned above that Jason was picking up on and reacting to these differences of opinion earlier in the semester. If Mr. Waters was doing too much of the explaining for students and not giving them enough opportunities to make sense of the material on their own and he feels this is an important aspect of teaching, then he may have been trying to get Jason to engage in this form of teaching, as well. This tension may be why it seemed by the end of the semester Jason had shifted his teaching orientation, at least based on what he was saying during his exit interview (1/9), down to be more teacher-centered (*Instructive* with a slight leaning toward *Transitional*; Table 7; Luft & Roehrig, 2007). A lot of what he discussed in his Exit Interview related to creating more consistent and controlled structures in the classroom:
One of the first things I need to do…before I could even start to talk about anything, the class needs to be controlled… (Jason, Exit Interview, 1/9)

Jason continued on to say that he felt his mentor’s teaching style was starting to “rub off” on him, even though Mr. Waters management style was “more fear-based control” and Jason knew “that’s just not me, I can’t do that, and I don’t want to do that because I think that’s wrong” (Jason, Exit Interview, 1/9). This resulted in him feeling torn between what he wanted to be doing and what he felt he had to be doing. But regardless of this tension, Jason held on to the belief that students learn best through discussion and participation in interactive lessons, and it felt good to him when he saw this going on in his classroom:

Something that I’ve been trying to get them to do more is to talk to each other about whatever it is, and I feel really good. They’re not perfect at it yet, but I feel really good when I’m walk[ing] around the room, and I hear kids actually talking about the problem. When I hear kids saying, “I got this answer, and you got this answer,” and they they’re actually discussing it. It’s not all of them yet, but they’ve made progress. I know that they’re engaged. I know that they’re having some kind of learnings going on when they’re discussing what their ideas are with the person next to them. I think it’s important for them to discuss things with me, but I think it’s even more important for them to be talking to each other. That’s something they don’t do enough, and that’s something we’ve been working on. That’s even like up there is stressing to listen, not just listen to us. You need to listen to each other. That’s important. (Jason, Exit Interview, 1/9)

At the end of the study, Jason’s teaching orientation may not have been as well defined as when he began, likely due to the ongoing conflict between what he deeply believed and what he was seeing in his residency placement. However, as the semester progressed, he was starting to take more ownership of his teaching experience and taking more of the risks he wanted his own students to take. It was also clear that he was able to think about how to adapt his instruction, even though it was still taking him more time to
do this effectively. For example, his mentor mentioned Jason was doing a good job adapting between classes, but he could see that Jason was picking up on where he needed to rephrase questions during class, too (Mr. Waters, Exit Interview, 12/18). Additionally, when Jason watched others teach, he was attuned to the interplay between what the teacher was asking, how she was asking, and how the students were adjusting their own answers as they started to figure out the purpose of the discussion (Jason, Exit Interview, 1/9). This level of interest in the collaborative meaning-making between the students and the teacher is pretty insightful and shows he was starting to move towards a high noticing skill level.

*Estelle*

Estelle, as described in Chapter 4, worked with a slightly younger age group than the others in my study, and taught both mathematics and science, not just one or the other. She is a fun teacher to watch, in that she clearly loves her students and loves helping them learn. She is animated and engaging. Even early on, she was constantly moving around the room keeping track of students. Her teaching orientation was fairly teacher-focused (*Instructive/Transitional*; Table 7; Luft & Roehrig, 2007). She chose to become a teacher in this urban environment because she felt she could provide her future students opportunities they might not otherwise get. She had spent a couple of years working with elementary students, so was also comfortable paying attention to not just behaviors, but also whether or not students were accurately learning the material covered (*moderate* noticing).
Finding one’s footing. When I observed Estelle the first time, her mentor changed the mathematics lesson last minute and therefore Estelle was less involved in the instruction than she had intended. However, she had been made aware of the general plan over the weekend, just not the specifics for that day. Estelle admitted during the follow-up interview that she only recently had gained access to the district curriculum for mathematics and was focusing her attention to lesson planning for her methods classes (Estelle, Post Observation #1 Debrief, 10/8). These impacted her ability to help with planning, but she still made planning and running the entry tasks for both mathematics and science a priority (Collaborative Reflection Log, 10/8).

During this first lesson, students were making two-dimensional skyscrapers out of construction paper to demonstrate and practice the use of arrays for counting. During the lesson, Estelle regularly checked in with her mentor to make sure her pedagogical decisions were consistent with the mentor (Estelle, Post Observation #1 Interview, 10/8). For example, she later recalled that they usually have challenge questions for students and that day, because she hadn’t been involved in the planning, she had to listen in on her mentor to figure out what the day’s challenge question could be.

Throughout the lesson, Estelle moved from table to table, checking in on students. She spent a lot of time with one particular table, though. This group had a boy seated by himself adjacent to them who had developed a strong relationship with Estelle. It turns out this student was one who posed a particular challenge for her at the start of the semester, enough so she brought him up as a dilemma to discuss in Seminar (Seminar
Field Notes, 9/26). Later I would recognize him from her descriptions when she had talked about how his self-confidence was increasing in part because of her ability to connect with him around football references (Seminar Blog Entry #3, 10/12). By this point, Observation #1, she had already earned his trust, which manifested through him constantly checking in with her to make sure he was correct. I observed that she was very kind to him and helped him by asking him if he used repeated addition and then immediately telling him to “add 8 three times” (Observation #1 Field Notes, 10/8). When asked about this, however, she recalled that she had asked him more questions than this and pointed out a resource available to him, which was partially true (Post Observation #1 Interview, 10/8). She did point him toward a wall chart with a series of options for multiplying, but she had already given him the solution.

I asked if she could think of some ways to try to help this boy have more self-efficacy, she admitted that she partially responded to him based on her experience with him writing multiplication problems and doing them all wrong, but also knowing he can add really well. This made her realize she could have given him a different type of hint, such as, “Do you want to make some groups?” She thinks this would have prompted him to think about what other possible options were available to him (Post Observation #1 Interview, 10/8).

When asked what she was looking for from students to indicate to her they understood the arrays and were ready for a challenge, she said she was looking for them to complete the arrays on their own. This agrees with the fact that her criterion for giving
challenge problems to students was whether they finished the activity. She also acknowledged that no one was working with challenging numbers, so many were able to finish quickly. She felt some of the difficulty with using bigger numbers was because the activity involved a lot of fine motor skills (cutting construction paper and gluing it down), and possibly students were selecting easier numbers in order to make it easier to align their arrays.

Generally, at this stage, and possibly due to her not being fully involved in planning this lesson, Estelle seemed unaware of how to deepen students’ understanding of the content. Estelle and her coach took some time to explore this issue in the context of this particular lesson. Estelle said they had been working on arrays a lot, so she thought most students were perfectly capable of doing this activity and she felt the goal was merely to give them another way to practice using arrays. Her coach tried prompting her to think more deeply about the purpose of the day’s lesson. Eventually the coach suggested the learning was in the multiplication itself and not the arrays specifically – just that arrays are another tool for making sense of multiplication. To this, Estelle responded they are familiar with this being a tool and they (she and her mentor) are always asking them what strategies they used and this activity just gave them another visual representation to work with. At this point, she said, her students could articulate they are comfortable with particular strategies, so her coach then suggested that it might be better to start thinking about asking the students why they like to use certain strategies and then draw a connection to why they might have chosen smaller numbers for this task.
Estelle acknowledged that this made sense, but did not contribute to this discussion other than to agree. The coach then ended with a suggestion that this would lead to a nice real-world connection of looking at skyscrapers with uneven rows of windows and calculating how many total windows are present. I am not sure Estelle understood her coach’s point, except that she nodded and we had to end the interview due to time.

When I read through Estelle’s second lesson plan for science methods, I was struck by the creativity of the lesson. She and her partner were trying to have their group of students organize the planets in our solar system in order using some different pieces of information that somewhat related to the scaling they had discussed in the first lesson. Unfortunately, the lesson seemed to be at too high a level as it referenced several facts the students wouldn’t be familiar with and wouldn’t be able to make the leap in logic necessary to organize the planets correctly; for example, the temperature of Venus is misleading as compared to the temperature of Mercury. Based on her reflection, this issue did arise and resulted in their having to explain why Venus is hotter than Mercury. Students did not use the characteristics used in the activity to differentiate between planets, instead they relied upon their prior knowledge, which indicates to me that this lesson did not work as well as Estelle and her partner had hoped (Estelle and partner, Science Lesson #2 Reflection, 10/21). Again, this seems to be an issue with Estelle’s ability to parse standards and align them appropriately with what students are doing during a task.
Learning by doing. As the semester continued, Estelle continued to have difficulty identifying the purpose of lessons. This was especially clear to me because she emphasized task-oriented parts of the two science lessons I observed. In the first, during Phase 2, her lesson was an engaging activity that encouraged students to use their prior learning about landslides to generate suggestions for how to prevent landslides. She began the lesson with a series of photographs of different ways people have prevented damage from landslides. This connected directly to the previous lesson, wherein students devised their own ideas for reducing damage from landslides. However, she didn’t take time to encourage the students to connect the facts they knew about landslides (e.g., slope of land, amount of water, etc.) to the design features they saw or came up with. Instead, she moved on to the next activity, which ended up with the students recapitulating their previous ideas and the ideas they saw in the slide show. Estelle opted to move forward and did a thorough job of guiding the students through how to give presentations and how to provide appropriate feedback on presentations through careful modeling. However, despite so much attention to how she was guiding students, she got off track from the purpose of the lesson and even the “glows and grows” (i.e., peer feedback) focused on superficial ideas and not the content (Observation #2 Field Notes, 10/23). When asked about the focus of the class and her alignment to the purpose laid out by the curriculum, Estelle said she and her mentor had discussed this issue a little and thought they would just add an additional mini-lesson to lead a discussion differentiating prevention and protection (Post Observation #2 Interview, 10/23). Considering the curriculum chosen by
her mentor, Ms. Mary, is model-based and involves a lot of well-written guidance for students to think about the processes they are observing, it is surprising that this wasn’t more of a concern for Estelle and her mentor.

During this Phase, Estelle was taking more and more control of science, especially the fourth grade science classes. She was going through the curriculum (Mystery Science; Mystery.org) ahead of time and familiarizing herself with all aspects of the unit, including materials and videos. Video watching was a big part of the curriculum, and Estelle was very thoughtful about how to incorporate the videos into class effectively. For example, she incorporated an article she had read in science methods about interactive word walls (Jackson, Tripp, & Cox, 2011) into a lesson using a video about hurricanes that she thought was at too high a level for her students. Through rewatching the video and co-constructing a word wall, her class was able to navigate this video effectively (Estelle, Post Observation #2 Interview, 10/23).

I noticed that sometimes she slowed down the pacing a little too much, but not for the purpose of helping students understand the content. For example, during Phase 4, when Estelle led a chemistry activity about cleaning pennies, she had the students watch and rewatch the methods video so many times, several students went home and did the activity on their own before they were able to complete the task in class. This wouldn’t always be a bad thing, but it led to what seemed like a lot of inattention during the activity because so many students appeared to already know what to expect (Observation #3 Field Notes, 11/26). Then she didn’t know how to refocus the group around thinking
about and discussing the mechanism they were exploring, rather than the actions they were taking. I think it would have helped to smooth the lesson and lead to deeper thinking if she had called students’ attention to the details of what they were observing rather than focusing on the physical task they were performing.

This issue of focusing on physical tasks over content indicates that Estelle seemed to miss the point of the lesson she was leading. The curriculum specifically asks students to draw and label a diagram showing what they imagine was happening in the experiment if you could zoom in up close. When reading the directions, I noticed that Estelle glossed over this part of the instructions. This resulted in every student drawing a hand holding a penny in liquid and half the penny being cleaned. When she asked students, before they drew their pictures what they thought happened, they used descriptors like “melt,” “dissolve,” and “remove” (Observation #3 Field Notes, 11/26). Yet not one student showed what they meant by these terms on their worksheet. In fact, I observed:

She never pushed kids to explain their inner models. Which means there is no discussion of evidence supporting these ideas… It seems Estelle takes their analogies at face value (“melting”), but doesn’t push to clarify or explore these ideas. Which means she is missing out on rich discussion and opportunities to use scientific practices beyond doing experiments. (Observation #3 Field Notes, 11/26)

When I asked Estelle about these ideas, she responded:

That’s why I really wanted to reiterate when [a student] said he thought that the penny, that the dirt melted off, what the next thing they’re doing is they’re figuring out why the penny isn’t shiny because there is a layer of dirt on top, was it always, and then what happens to that dirt when it goes away, does it just evaporate into thin air? That’s what I was trying to prompt with that because that’s what they’re going to figure out next. That’s why the revised model is the 2A and 2B they’re going to answer it next time once
we talk through a bunch of stuff. We’ll just really explain and elaborate.
(Estelle, Post Observation #3 Interview, 11/26)

Here she is talking about addressing these terms with one student, and only through
giving him part of an explanation rather than asking him to dig deeper into the reasoning
behind his answers. Given Estelle was still struggling with identifying the important
features of lessons, this isn’t surprising. When I asked her what she thought students were
testing, she wasn’t really sure.

Estelle struggled to effectively adjust the lessons to get at the deeper meaning
behind the content being covered. Instead she tended to focus more on the logistics of the
lessons and getting through the activities and assignments, rather than focusing in on the
meaning-making portions (Post Observation #3 Interview, 11/26). Based on my
observations of her, her answers in interviews, and her coach’s observations, Estelle was
working hard to balance a great deal of responsibilities in her classroom early on and
possibly this was detracting from focusing more on content. However, despite looking
less at the meaning making that can be done with the content, she was making huge
strides and was very open to suggestions (Coach Nan, Formal Observations, 11/28 and
12/5).

Reflecting on the past to look ahead. It was evident by the end of the semester that
Estelle had a decent appreciation for engaging students in their own thinking and how
this fits the 5E lesson structure (Bybee et al., 2006). In her Science Methods Reflective
Essays, Estelle specifically addressed the importance of identifying students’ prior
knowledge and using this to help construct later lessons (12/14). She was still relying on
student data in a more reflective way, though, and not adjusting lessons in-the-moment much, if at all.

When I asked her mentor about Estelle’s ability to identify and reflect upon student thinking, she said:

I think her ability is right on target. She’s come to me and she said specifically, ‘He’s not seeing that piece there,’ and it has been very specific. I’m really impressed with her ability to hone in on that… I think her biggest strength is in analyzing trends, and then boiling down what the issues are that need to be revisited. Then, doing that in small groups. I think that’s very cool, because it shows two things. Number one, it shows that she’s looking for specific things, and number two, it shows ‘Okay, not only do I know that, now I’m going to fix it.’ That’s great. (Mentor, Exit Interview, 12/19)

It is interesting that she specifically mentions Estelle’s ability to address student needs in small groups, as this implies she is doing this between lessons. I think this may have to do with the fact that Estelle made it a habit from very early on in the semester to check in regularly with Ms. Mary all throughout a period and if she needed to adjust, Ms. Mary would provide her some direction in this way, but mostly about pacing (Estelle, Post Observation Interview #2, 10/23). She checked in less as the semester wore on, but was still receiving written feedback periodically at the end of periods. Their relationship was one of trust and Ms. Mary believed in Estelle’s ability to lead and teach science classes, so she tended to be more hands off.

_Teaching orientation and noticing ability at the end of the study._ By the end of the semester, Estelle’s perspective about what her role is as a teacher had not changed much and she still had what I think of as a “uniform” mentality about teaching, where one
learns some skills and then gets in front of students and magically becomes a teacher who can impart knowledge onto students:

I think my role is to serve as an educator for young people. Right now my role is educating through math and science. I know it also can expand to more of the soft skills like working with others, making healthy communication, problem-solving. I see myself as kind of a person who is learning how to do that well… It means to pass on knowledge or to help students find their own knowledge about a specific subject.

I think through the different strategies I have learned. Trying to let the students figure things out for themselves, but also provide them guidance when they can’t figure it out. Letting them do the experiments that they want to do and not just the ones that are easy for me to do. Making sure that they get the most out of a lesson. Making sure that they know that this is important. That this will serve them later in life. (Estelle, Exit Interview, 12/21)

This means Estelle’s orientation appeared to be more strictly Instructive (Table 7; Luft & Roehrig, 2007). And despite learning to pay attention to what students are thinking to some extent (“If there’s a student that looks lost I’ll try and call them out to see where their brains are at,” Exit Interview, 12/21), her noticing ability was still primarily moderate, as it was focused on whether students were correct or not. For example, after watching the short video of a classroom interaction, she had only decided that students either understood or were confused, but couldn’t articulate more about that. Even the decision to identify one student as confused only used partial information, as she wasn’t able to follow the student’s place in the conversation and how this may have changed as a result of the teacher asking questions and the other student trying to explain his thinking (Exit Interview, 12/21). This aligns with what I saw in class, where Estelle was gathering partial information and not yet able to construct clear interpretations of what students
meant by their responses to her or each other, but that if she had some time to process, she could identify the general abilities in class and predict which students might have difficulty based on their past experiences.

**Vale**

Vale stood out during Phase 1 as being a relatively reflective and student-centered preservice teacher. His calm nature and strong belief in the power of exploring questions students are naturally interested in and using questioning to guide students as they learn ranked him as an already pretty *Responsive* teacher. Because he was still mostly looking for whether students were giving specific responses he had already identified as “correct,” he had a *moderate* noticing ability. But his appreciation for other people’s ability to listen carefully to students and adjust their questioning and guiding accordingly suggested potential for learning how to notice effectively sooner than his peers.

*Finding one’s footing.* During Phase 2 of my study, Vale’s goals shifted from focusing on classroom management to engaging in the conference-style discussions his mentor leads. The classes are a little smaller than is typical in the city, which allows the mentor to engage students in conversations around content, rather than direct instruction. However, as Vale had been primarily involved in moving students smoothly from the hallway into the classroom at the start of class, he naturally took up an assistant role during these conference table conversations and would mainly monitor academic and social behaviors.
Vale took the opportunity to move some of what he was seeing in his residency placement into practice when he and his partner planned their first science methods lesson. When they wrote their lesson plan, they included a series of possible answers students might give when asked to explain a photo of a person who appears to be holding the Eiffel Tower. And then they included suggestions on what to do in the event they heard each response. These responses are initially based on accuracy, but then either push students to re-evaluate their ideas or start to apply vocabulary. The following is from the “engage” portion of Science Methods Lesson #1 (10/5):

The person is really big and can hold the things seen in the pictures. Incorrect – Ask the students if they know how big the Eiffel Tower and if they know any person that could be that size.

The people are just standing far away making it look like their bigger/smaller than what they really are. Correct – Ask the students if they know what that kind visual trick is called.

I don’t know/understand what is going on in the picture. Unsure – Show students other pictures and have them think about if the objects are really as big/small as they appear. (Vale and partner, Science Methods Lesson Plan #1, 10/5)

Here you can see that Vale and his partner took time to think about what types of responses their students may give. By preplanning out the types of responses students might give during the lesson, Vale was able to solidify his goals for the lesson and be prepared for redirecting and guiding through use of more open-ended questions during the lesson. This skill is something Vale credits his mentor with teaching him:

That’s this big thing I was talking about that earlier about how it’s all just about making them figure it out or trying to get them to figure it out themselves or come up with answers. You never give them an easy answer
which is a lot of what I’ve learned from [Mr. Bob]. It’s stuff like that. (Vale, Coach Debrief Observation #1, 10/8)

To Vale’s credit, in order to say and do this, he has to agree with his mentor about this method, which his mentor refers to as “teacher directed, but student friendly with some parameters” (Mr. Bob, Post Observation #2 Interview, 10/23).

I had a chance to witness the types of questions his mentor asked during a class discussion about what happens when vinegar and baking soda mix. Vale’s mentor took time to ask about where each component was and where new ones, such as the gas formed, came from. This helped focus student attention on important details, which lead to discoveries about chemical reactions. This is a challenging skill set, as it is difficult to ask good questions without having first a strong belief that certain types of questioning are useful in learning. Additionally, the teacher needs a strong grasp of the content, enough to be able to identify good questions to ask that focus attention but do not give away the answer.

To support Vale’s ability to question and feel comfortable stepping in, he had been involved in some lesson planning, but mainly through discussion after the plan was made:

I would say at this point what we do is we’ll sit down most mornings and just talk about what the day’s going to be like and who we’re going to have and what we’re going to be doing and what to look out for and what we’re collecting and if I have any ideas about anything. Then we’ll run through them and decide whether or not there’s something that would be viable options for the classroom. (Vale, Post Observation #1 Interview, 10/8)
Here he admits that he isn’t heavily involved in preplanning, but he does get to discuss in detail what the purpose of the lessons are and how he can be involved. During this time, they discuss key features such as learning goals, ways to demonstrate phenomenon, questions that can be asked, and challenges that may be encountered (beyond behaviors). In a way, he and his mentor teach the lesson before they teach the lesson. By focusing in on the purpose of the lesson, Vale gets to practice identifying these types of goals while also learning to develop a technique for guiding students to think about these ideas.

Vale also gets to see how his mentor establishes and maintains discussion-based lessons. Sometimes Mr. Bob has students “circle up” at the front of the classroom, where “the idea is that everyone is equal, anything you say is going to be valued” (Vale, Post Observation #1 Debrief, 10/8). He sees this as a very positive way to engage all students in content-driven discussion, but it also allows for adaptations according to specific student needs:

I think it’s a great way to be able to talk too and see everyone and have everyone feel like they’re being seen. I think it’s a great way. I think that sometimes I’ve noticed a few of our vision-impaired students tend to sit at this table [gestures to a front table] when that’s happening. (Vale, Post Observation #1 Debrief, 10/8)

Despite so much modeling and support from his mentor, he still struggled with the execution when on his own, but was very aware of what he was doing and reflected on this openly:

Then someone else had said that they thought CO₂ itself was carbon. That that whole thing was carbon. That’s why they hadn’t understood what the
C stood for. I think maybe the problem there was that when the students answered it, I tried to reiterate it to say, ‘So, the C stands for carbon, right?’ But I think I maybe should have pushed them to write things down more maybe, but also there was some gap there where they weren’t getting what I was saying. (Vale, Post Observation #1 Interview, 10/8)

**Learning by doing.** It is possible that the combination of Vale’s and Mr. Bob’s teaching orientations resulted in a more supportive environment for Vale to reflect and grow in terms of his noticing ability. However, even going into Phase 3 of the study, there were challenges that impeded his ability to practice noticing during class; for example, he still felt a little uncomfortable stepping in during class, especially if his attention was split between multiple duties:

Today unfortunately [the transition from monitoring lunch detention to class and back] didn’t work out very well… Even when I did sit down, I understood what you were going over with them and I knew what was going on, but for me to come in, jump in and say something and then get up and leave again isn’t super great either. I think that’s the first time we’ve done lunch detentions in here during another class. (Vale, Post Observation #2 Interview, 10/23)

It was unclear how often he was asked to monitor detention, but it was clear that he was taking on more responsibilities in the classroom and school, which meant his attention was being divided. Therefore, even though he valued learning from his mentor, he was still navigating the systems for getting involved.

Despite his divided attention, once he was able to join the class discussion at the conference table, he immediately jumped in and took on a role that modeled for students and engaged them in the discussion. For example, while the class was examining a
complicated diagram in their textbook, Vale saw room for stepping in and encouraging students to look deeper into the meaning of the diagram:

I made sure that I said anyone think more than 6 [pieces of information from the diagram], which is why I had my hand up for that, because I didn’t think [Mr. Bob] was going to go 7, 8, 9, 10, 11, 12. Right? Because most of them had already thrown in their hands at 5 or so. Before then, a lot of them. However, the idea was still to push it, right? (Vale, Post Observation #2 Interview, 10/23)

It is also remarkable that Vale already had the ability to place himself in both the shoes of his students and his mentor. When asked to speak further on this point, it sounded as though this was something Vale had either decided to do on his own previously, and/or was encouraged to do by his mentor.

We’ve done some things like that before. There definitely have been situations where my role is almost being a student who just knows a little more than others. (Vale, Post Observation #2 Interview, 10/23)

Vale was also already quite aware of the limitations of his ability to keep track of student ideas during these interactions:

This is the part of the instruction where you are just trying to lead them toward water and hope that they can put some things together on their own and Mr. Bob is great at that. One of his big teaching philosophies is asking questions and making the students find out the answer. I’m still learning a lot about how to do that from him. I didn’t notice some things. I asked some students to take their hood off and keep their head up. It’s mostly classroom management things that I noticed. (Vale, Post Observation #2 Interview, 10/23)

It is difficult, however, to know if at this point his focus was more on management because his role was more as a background player in instruction.
Looking ahead to student teaching. As the semester progressed, Vale continued to take instruction and look for ways to push himself in the classroom. His coach noted that he was very reflective and able to weigh the strengths and weaknesses of different strategies presented to him (Coach Nan, Formal Observation, 10/23). His reflective nature came out in Phase 4, when he attempted to adjust the third lesson from his Science Methods Field Experience to fit into his residency context. He attempted to adjust the lesson between when he cotaught it during science methods and when he brought it to his residency site. There seemed to be some confusion about what his coach was looking for, and therefore he planned a little too much for one period. This was most likely due to a miscommunication in the science methods class, where the instructor had not provided much feedback to the residents about their lesson plans or instruction (Science Methods Field Notes, 10/26).

As a result, Vale and his coach discussed extensively some of the challenges he encountered and some alternatives to what he ended up doing. He was very thoughtful about this and acknowledged he probably should have realized his students might not have had the same background knowledge as the small group of students he worked with for his methods class (Post Observation #3 Interview, 11/13). His coach also encouraged him to think more about the phenomena involved and try not to introduce too much vocabulary too quickly because it was just getting ignored by the students. Vale’s thoughts on this were that he felt it was important to introduce these terms, even if only briefly, because he wanted students to grapple with them a little. His mentor then stepped
in and said he wished the lesson had been spread over three days, instead. Vale agreed, and proceeded to describe how he might break down the lesson a little bit (Post Observation #3 Interview, 11/13).

It is important to note that some of his irritation with the lesson plan was because his science methods instructor had not done an adequate job of explaining the 5Es (Bybee et al., 2006) to him and his classmates, even after they had written three lesson plans for the class. This led to some tension around these expectations, which his coach attempted to alleviate during the Post Observation Debrief.

Vale and his mentor eventually decided that Vale had been practicing all the different teaching tasks he would need to master and it was time to start doing them all at once (Collaborative Reflection Log, 11/21). As he took up more responsibility by taking over the seventh-grade classes, Vale appeared to progress well, however, classroom management was slipping, and Mr. Bob felt the need to intervene a little (Collaborative Reflection Log, 12/4).

Reflecting on lessons learned. I did not get to personally observe Vale late in the semester, but based on my conversation with his mentor, Vale was doing really well when it came to engaging students in evaluating each other’s ideas and, therefore, increasing their own understanding of the material they were covering:

[For a recent lesson, the students] were expected to gather [information] themselves, and then he solicited, ‘Hey, what did you get?’ and would bounce [ideas] and say, ‘Well, Katia got this. Ahmed got this. Which one is it?’ I would say that for that activity, he was really good at not just giving it to them, but getting information from them, but then making sure it was
clear to them what the expectations were for the factual parts of that assignment. He wrote it on the board, too. (Mr. Bob, Exit Interview, 12/19)

Earlier in the semester I asked Vale about assessment practices in his classroom (Seminar Field Notes, 10/24). Vale had been struggling with one student who was not writing anything down in his class, but seemed to be physically engaged with the content when they were doing activities. I asked him if he had simply asked the student to explain his thinking to him orally. Vale seemed surprised by this suggestion. Yet, at the end of the semester he was finding it easier to engage students in discussion and determine how well they understood the content using information from more than what they were writing down in class. When asked about how he felt about this process, Vale admitted he really enjoyed engaging students in their own thinking. He finds students interesting and he can see how being able to engage students regularly is beneficial for everyone and a positive experience for him.

I like hearing students’ thoughts on things. I find that sometimes, it would almost be better like walking around the class helping them with these formal assessments. Sometimes I get more of an idea of their understanding when I’m answering their questions or helping them through something than I do by reading the formal assessment at the end of class. I think being able to verbally explain what’s happening is something I like. I like being able to see where the thoughts are going rather than just reading it on paper. I like experiment-based stuff. It’s saying, ‘Okay. How could you do this same thing but with,’ and then throw a completely new idea of a situation at them where they have to apply the same thing that they’ve been learning. It’s more of a spur of the moment kind of, ‘How well do you understand it,’ kind of thing. I’m finding that that’s the way I like to assess, which isn’t maybe something that’s going to be so easy to do as a [stand-alone] teacher. (Vale, Exit Interview, 12/19)
As Vale explores assessment and engagement in class, he is also seeing that they are useful for directing instruction, acknowledging the interplay between teacher and student.

Vale and Mr. Bob had a lot of beliefs in common and Mr. Bob appreciated how open and inquisitive Vale was throughout the semester. Even after he was starting to take over more of the instructional lead roles, he and Mr. Bob continued to engage in coteaching and debriefing.

I led [the class] discussion these last few days. Afterwards, we talked about it. He was like, ‘What’s your thinking? What were you doing?’ Using the lecture to support what we’re doing in that textbook, but I think by seeing me not give answers, but lead students to those concepts with those three particular laws, I think he was curious about it. ‘How am I getting learning from the students? How am I helping them develop as learners?’ By asking questions. (Mr. Bob, Exit Interview, 12/19)

This give and take between Vale and his mentor was important to Vale and he was very thoughtful about the lessons he was taking home from his experiences. This reflection included his understanding about the ways Mr. Bob is different, as a veteran teacher, from himself. For example, he feels uncomfortable making decisions about what students should or should not be covering in science class, so he plans on trying to stick to the district curriculum plan as closely as possible, despite the fact that he has seen his mentor make these types of decisions and slowed down instruction significantly.

I can’t just start out and say, ‘Yes. I know that they need a deeper [understanding of]…” because I don’t know anything. Covering everything might give me an idea of which parts are most important. I just plan on starting out that way, and then the next year I’ll know what to focus a little bit more time on and what maybe is a little less important. Year after, I’ll have a better understanding. I think it’s something that’s going to come with time. (Vale, Exit Interview, 12/19)
Despite his desire to get some experience under his belt before making major curricular decisions, he still hedged a little about staying on pace with an outside requirement because he was concerned about the progress of his students. Vale added that he would want to incorporate reteaching “instead of moving on,” which will require some skills he will need “to learn on the go” (Exit Interview, 12/19).

Given he was already very attuned to individual students needs and the general goals of the classes he was coteaching, I do not think Vale has as much to learn as he thinks. However, it is significant that he sees being a teacher as something you continue to learn how to do, even after he finishes this program.

*Teaching orientation and noticing ability at the end of the study.* Overall, Vale started the year extremely reflective and, with the support of his equally thoughtful mentor, Vale continued to grow toward the Reform-based (Table 7; Luft & Roehrig, 2007) teacher he initially indicated he wanted to become. His responsiveness grew, too. Although not always able to consistently adjust his instruction on-the-fly, Vale was showing that he had a high ability to notice student thinking and not just retrospectively. Vale was already adept at reading student body language and listening to how students were answering his questions to the point of being able to identify with some accuracy the depth of their understanding. But most impressively, to begin asking additional questions, not just of the initial student he was engaging, but of their peers, so as to draw in all learners. As his coach summarized in her final observation of the semester, Vale
was going to be starting his formal student teaching having already established a highly functioning and collaborative classroom:

Vale demonstrates his ability to manage and engage students appropriately. His students listen to and respect his authority. They engage with him and in lessons. Vale utilizes student input when going over tasks, questions and/or content. His students willingly volunteer to share their thoughts. Vale’s students always know what is expected of them and they perform accordingly. They remain on task and there is a consistently healthy ‘working chatter’ amongst them. (Coach Nan, Formal Observation, 12/5)

Research Question 3: Comparing Across Content Areas

This section will briefly discuss patterns (or lack thereof) in the opportunities and affordances available to residents between content areas. Two residents were in math-only classrooms, three were in science classrooms, and one was teaching both mathematics and science, therefore coverage of both content areas included in this study were fairly balanced.

Although at first glance the three PSTs who tended toward having more teacher-centered instructional beliefs were all teaching mathematics at least part of the time, I do not believe this was due to the content itself. I asked every resident if they thought about teaching the other content area and most said they did not want to; however, one did think math sounded like a more straightforward subject to teach. Despite this, even this person qualified this with an explanation that they just feel math is more highly valued than science and therefore might not have some of the peripheral challenges they experienced in science. Instead, I suggest that beliefs about what is mathematics versus science and how each should be engaged in by learners is more important. The two
heavily math-oriented PSTs were more likely to have more traditional ideas about what it means to teach mathematics. Janice was particularly reluctant to consider embracing trial and error as a means of learning mathematics. The other two who taught mathematics (Anthony and Estelle) were a little more open to having students try and share multiple methods, but still leaned towards ultimately having the teacher determine the best way to learn and do mathematics.

There are multiple reasons why the science-focused teachers were a little more flexible in their thinking about what it means to learn. It could be the fact that their personal histories involved various degrees of self-discovery and exploration. The most responsive, Vale, was raised in a household that valued self-exploration into questions about the world and he carried this into his own classroom. The least responsive of the science PSTs had a strong science background, but was heavily concerned with the act of doing science rather than thinking deeply about scientific ideas. Alternatively, it could be that people who leave science career trajectories do so because they do not relate fully to the culture of being scientists and instead find comfort in working closely with others. I know from my own experience that doing science can be very lonely, and as you move up to more managerial positions, as Luke had, you start to feel more isolated. Ultimately, however, I am inclined to believe that most of the observed differences were the result of a combination of mentor beliefs and goals, resident beliefs and goals, and the systems in place to support development of each participant, mentor and resident alike.
Summary

Despite having a lot of common experiences (e.g., coursework, programmatic expectations, and coach), each primary participant had their own unique set of circumstances during their first semester of the residency program. The most defining experience appears to be heavily related to how a resident’s personal beliefs about teaching and learning interacted with their mentor’s beliefs, practices, and ability to unpack their own practice. In the preceding case studies, I have attempted to describe examples of key moments in the development of these residents as they navigated learning how to notice student thinking.

Most of the residents were in placements with significant challenges. These challenges ranged from mismatches between teaching orientations and values to mismatches between communication styles to simply being poorly managed classrooms. Almost all residents got along personally with their mentors, but due to the aforementioned mismatches, their development appears to have been impacted. Although it is difficult to draw definitive conclusions based on this small group, I have developed a few assertions that these data bear out. In no particular order, these assertions include the following and will be elaborated upon in Chapter 6:

1. Dyad matching: Mentor and resident dispositions when matching occurs.
2. Targeted mentor training: Mentors need more specific training and guidance in terms of how to unpack their practice.
3. Focused attention on content purpose: Residents benefit from specific guidance about how to identify and then hone in on the key content-level elements of lessons.

In Chapter 6, I will not only explore these assertions further, but also discuss how my understanding of the teaching apprenticeship, and residency experience as a whole, has changed and some of the implications of my findings. I will also discuss limitations to this study and describe some suggestions I have for future research projects as a follow-up to this study.
CHAPTER 6
CONCLUSION

Summary

The current structure of the teaching residency model in this study aligns with Situated Learning Theory (Lave & Wenger, 1991), and particularly cognitive apprenticeships (Crawford, 2007; Dennen & Burner, 2008). The residency provides PSTs access to authentic teaching experiences by matching them with cooperating teachers who take them under wing and slowly integrate them into the daily work of being teachers. The program tries to integrate theory and practice through providing access to knowledgeable mentors who serve as bridges between the world of teachers and the world of theory (i.e., university courses). This study examined how this program introduced and supported the development of noticing practices in PSTs throughout the first semester of the program.

Multiple studies have examined residencies in terms of achieving desired goals around producing educators specifically prepared to teach in high-need urban locations (reviewed by Anderson & Stillman, 2013). A major gap in these studies and the usual perspective on mentor-mentee dyads is the focus on specifically understanding and relating to a community while ignoring, to some extent, the need for content-specific instructional rigor and focus. Tying together the structure of a cognitive apprenticeship and the focus on content-specific pedagogical choice can potentially lead to a shift in how we recruit, train, support, and maintain both current and future educators. The inclination
to focus on behaviors rather than content means there needs to be a special effort in place to help PSTs learn pedagogical skills necessary to become effective responsive educators. The use of a social constructivist framework makes sense in terms of thinking about how to improve teacher education programs through conscious shifts in program design. This study can potentially lead to a different way of thinking about how we approach preparing and supporting mentors and interns in the future.

To address this issue of how novice teachers learn to engage in specific and effective teaching practices, this study was designed to examine both how PSTs engaged with noticing practices and how different aspects of a teacher residency program afforded opportunities for preservice teachers to engage in, practice, and develop noticing skills. The field experiences and mentors (and university courses to a lesser extent) provided residents legitimate access to members of a teaching community of practice. The residents’ access was restricted (peripheral) in a way, though, as they were interns who were not responsible for all teaching and school-related responsibilities at any time during the pre-student teaching phase of the program. Additionally, although the residents were given direct access to this community of practice through formal means, a majority of the learning involved was unstructured and through interactions between players, rather than formalized learning structures. As a result, residents received variable access to information relating to specific pedagogical practices, including noticing. This resulted in a variety of outcomes in terms of noticing abilities by the end of the study period.
When I began this study, my intention was to explore how residents incorporate their different experiences into new knowledge. To this end, I did observe how much they seemed to draw from different programmatic experiences. University courses, excluding field-based assignments, provided few opportunities to engage with or learn about noticing, however they had larger implications for relationship building and classroom management, which were outside the scope of this study. Even when given an opportunity to explore student ideas (e.g., misconceptions or sense making around mathematical algorithms), it was unusual to hear residents discuss how these relate to their classroom experiences. The reciprocal was also the case in that residents rarely referenced examples from their university courses, except to sometimes reference material from their development course and discussions held during seminar. This is not too surprising, as these courses and the instructors who taught them represent members who are on the boundary (Wenger, 1998a) of the community of practice and therefore act as knowledgeable others, but not key insiders. Even though the field experiences connected to the methods classes and the reflective seminar provided opportunities for residents to practice identifying student learning, they did little to encourage reflective practice around these ideas due to the structure of the courses. The three mathematics lessons were not continuous parts of a unit and therefore residents had little incentive and opportunity to incorporate direct analysis of student thinking. The science lessons, which were part of a continuous unit, were not accompanied by much, if any, feedback, never mind directed feedback relating to student thinking. Therefore, unless the primary
participant had a personal interest in examining student thinking, they did not engage in this practice during these field experiences. The reflective seminar served as a bridge between boundary and insider (Wenger, 1998a); however, because it developed organically in response to the residents’ specific needs (introduced as “dilemmas”) the opportunities to discuss student thinking were rare.

In terms of their residency-based experiences, the primary participants had variable access to modeling and support relating to noticing student thinking. All mentors modeled to some extent engagement with student thinking. Some mentors were very responsive, while others were mildly responsive. For example, some mentors made a point of discussing examples of student ideas explicitly during classes and debriefs, thus directing PST attention toward this way of thinking about instruction. Other mentors only indirectly discussed student thinking by focusing attention on covering or avoiding typical or familiar global misconceptions as opposed to discussing individual student ideas. How involved a resident was in noticing student thinking appeared to be related to how directly and openly their mentor engaged in this practice, as well as the resident’s own personal teaching beliefs or orientation.

This issue of teaching orientation is an important one for thinking about how preservice teachers are using their field experiences to learn how to teach. From the perspective of Situated Learning Theory, their entire potential to learn specific pedagogical tools or ideas depends upon whether they get to see, engage with, and practice these tools in the environment in which they are normally used. If the mentor
does not use any given tool, then the resident cannot access the tool themselves. If the resident does not notice a practice because it is outside of their teaching lens as defined by their beliefs about teaching and learning, then they will not be able to learn how to use the practice. The beliefs of the residents provide some insight into what the resident thinks is important for learning to teach, and therefore what they will be looking for as they gain access to the community of practice. It is the interface between the resident’s beliefs and their mentor’s beliefs and actions where learning about noticing occurred (or not).

Because of their role as guides to the insider world of teaching, a fundamental element in the development of preservice teachers were their mentors. Mentors and PSTs in this residency context spent four days a week working side-by-side, with additional untold hours communicating through emails, phone calls, and text messages. There is no question that field experiences are important, but the specifics of what constitutes quality time in the field remains unknown (Anderson & Stillman, 2013; Dorel et al., 2016; Moore, 2003). This study sheds some light on the details of the aspects of residencies that influence the development of preservice teachers’ pedagogical skills. As a result, I have developed a few assertions relating to how mentors can and do influence preservice teachers. It is my intention that these assertions are suggestions for ways to think about how we can, as teacher educators, better serve future apprentice teachers.
Assertions

Dyad Matching

Mentor and resident dispositions should be considered when matching occurs. Given the importance of communication, both implicit and explicit, between mentor-mentee dyads, the personalities, goals, beliefs, and communication styles of mentors and mentees may be worth considering when making matches. In the situation of a cognitive apprenticeship, it is important that the cognitive piece be supported. If a mentor is unaware of the needs and abilities of their mentee, they will not appropriately identify the mentee’s zone of proximal development (Warford, 2011). Likewise, whether or not mentors have a clear idea of what they are looking for, if mentors are unsure of how to communicate appropriately with their mentee, they will not be able to achieve the results they seek (this issue will be revisited in other assertions).

I know this program tried to take into consideration personalities when selecting pairs, but ultimately matches were made based on convenience rather than information about the individuals involved. I also realize this is a particularly difficult goal to meet for most teacher education programs, especially in areas with high teacher turnover, low morale, or significant subject area shortages. However, this issue may be mitigated to some extent by appropriate mentor-mentee support from trained facilitators such as coaches and program leaders (assuming the coaches/leaders are seen as equals to the mentors and mentees; Veal & Rikard, 1998). During this study I observed how one particularly mismatched partnership was helped to some extent by outside support,
suggesting more structured support and clear communication of goals around outcomes for students, resident, and mentor from the start might have helped avoid some of the challenges. However, this certainly deserves more attention and I make some suggestions for future study (see Future Research).

**Targeted Mentor Training**

_Mentors need more specific training and guidance in terms of how to unpack their practice._ Currently this program provides some mentor training and support, but it is generic and left open to mentors to decide what topics to focus on. Because this program specifically encourages the use of 5E (Bybee et al., 2006) lessons and student-centered instruction, mentor training that focuses on these aspects may be beneficial. Coaches are a useful resource, especially if they are like the one included in this study, because of their expertise in related content and instructional practice. When mentors were part of the conversation between residents and coaches, there were some very rich discussions about student thinking and the implications for practice, both retrospectively and prospectively.

Just because a mentor chooses to be a mentor doesn’t mean they see themselves as a teacher educator (Rajuan et al., 2007). Instead, in my experience, they are selected by administrators who are looking at traits that are not necessarily the hallmarks of reflective practitioners: good classroom management, strong student test scores, and positive contributions to school goals or climate. However, just because someone is good at doing something doesn’t mean they are able to explain how they do it or that their guidance is
even useful (Mena, Hennissen, & Loughran, 2017). Additionally, once selected, they may see themselves more as role models rather than teacher educators (Rajuan et al., 2007). Instead, our cooperating teachers need training to become effective mentors. Training can work (Giebelhaus & Bowman, 2002), and has the potential to lead to greater communication (previous assertion) and learning (next assertion).

Focused Attention on Content Purpose

Residents benefit from specific guidance about how to identify and then hone in on the key content-level elements of lessons. The residents who were involved in all aspects of planning with their mentors from day one appeared to be more successful at learning to engage with students around content, even when outside their area of specialization (e.g., Luke and Vale); however being involved in planning was not sufficient to ensure this success (e.g., Estelle). The relationship between engagement with student thinking and familiarity with the curriculum became more apparent as more residents engaged in planning. This started to become clear once they had to start writing and implementing their own lesson plans for their methods courses. At this point the residents started to realize the complexity involved in balancing the dual goals of completing a lesson (pacing and management) and having students learn (content goal). As Anthony pointed out, being an effective teacher is a little like doing improv—you need to have a goal in mind, while also adjusting to the reactions of those around you.

My final assertion is perhaps the most valuable for content specialists to consider. When working in difficult, poorly resourced contexts, it is natural to focus on superficial
concerns such as behaviors and organization. Additionally, Anthony noted as I was writing this conclusion that it can be difficult to hear what his students are saying, making it tempting for him to reduce opportunities for students to talk and, presumably, return attention on classroom management. However, if the common goal of mentor, mentee, coach, and program is to improve content understanding in students, then the content needs to be front and center. Focusing on student thinking, in turn, helps to reinforce the relevant and necessary skills (Levin et al, 2009). In a cognitive apprenticeship, it is especially important to give apprentices (in this case preservice teachers) access to the specific ideas and ideals that lead to improved student learning. Non-academic behaviors, as distracting as they can be, are often secondary to real learning. This is, of course, a complicated subject, which to fully explore would require an in-depth exploration of cultural expectations and histories, however, based on my observations during this study, each classroom represents a potential opportunity to develop a common culture of learning. If the instructors value learning content in such a way that students are fully integrating the material into how they think about the world, students start to follow suit. We see this in Jason’s context, where the mentor-mentee dyad specifically pursued encouraging students to be open to co-generating knowledge through trial and error and open discussion. Similarly, we see this in Vale’s classroom, where his mentor starts from day one expecting students to think critically about every situation they encounter, and this process is facilitated through discussion between peers as much as between students and teacher. In classrooms where the primary concern was around behaviors, someone
lost out on opportunities. For example, in Luke’s classroom the students lost out because a lot of attention was on meeting specific physical behavior goals rather than making sure content was being covered and integrating this into behavior plans; likewise, Anthony lost out because his mentor couldn’t release control out of fear of not meeting specific calendar goals.

However, having these content-specific goals cannot be merely the mentor’s personal goal, they have to be the common goal of both mentor and mentee. In terms of situated learning, this means the mentee needs to be inducted into the context by way of content and not management. It makes sense that management is usually the first step in integrating an apprentice. It is easy to direct someone unfamiliar to do surface level things like take attendance and walk around the room reminding students to sit certain ways. Suppose the apprentice were first introduced to the academic purpose of the class? Wouldn’t it be easier to take care of the surface level things if the intern understands why those behaviors may lead to better learning? And couldn’t they then start to integrate themselves through engaging with student ideas? It seems as though it would be just as easy to ask an intern to make note of the types of questions and responses mentors and students produce through a period as it would be to ask someone to look for distracting behaviors.

Additional Findings

The intention of this study was to tease out the roles of all different types of experiences on PST development of noticing practices. As my analysis progressed, it
became clear to me that the number one influence was the mentor-mentee relationship. In Chapter 2, Figure 1 illustrates the relative impact the different aspects of the residency experience should have on PST learning about how to notice student thinking. Originally, my illustration implied an optimism that the mentor, coach, peers, and community would work more closely together to support PST development (see Figure 1). I have since revised this model (Figure 3), to illustrate the push-pull of PST and Mentor actions and beliefs. This figure is more reminiscent of a free body diagram in physics, where the forces illustrated may push or pull, and the coach can be either a support or a hinderance depending upon how well they align to the mentor and mentee’s beliefs and goals. The other bordering experiences (in light grey) are only drawn upon if explicitly recalled and purposefully integrated into the discussion, which rarely occurred in the field. Notably, several mentors mentioned during the Exit Interviews that they wished they saw or heard more about what their mentees were learning throughout the experience.
Despite the direct impact of the mentor on PST development, there are several other less influential experiences that I believe had roles, but were ultimately filtered through the mentor-mentee relationship. For simplicity, I will merely summarize these findings as bullet points below:

Course alignment

Methods

- Lesson planning in methods was only somewhat aligned to what PSTs saw in the field.
- Lesson planning was set at an opportune time, but not necessarily as useful as could have been given issues with support and feedback (particularly in science).
- It was good that both math and science use the same lesson plan structure, however, there were some mismatches between how the two were explained (the logic for the flow and the purpose of each phase) which resulted in some confusion, particularly when Coach Nan asked for formal lesson plans for her visits.

*Child and Adolescent Development*

- The organization of this course balanced early childhood and adolescent development from a variety of theoretical viewpoints.
- The flow of topics was extremely useful and, as mentioned above in terms of the Reflective Seminar, aligned well with resident experiences in the field.
- Several residents referenced content they learned in Child and Adolescent Development when explaining their thoughts about how to interact with students and not make unreasonable assumptions about what students’ lives are like or their capabilities.

*Reflective Seminar*

- This was a very practical class that often happened to align with Child and Adolescent Development. Because the two were on the same night, it is possible that what was being assigned for Child and Adolescent Development was influencing seminar discussions,
although to hear the residents talk about it, you would think it was coincidence or kismet.

- Despite the program trying to influence the direction of this course, the fact that the instructor kept to a more organic syllabus that responded to the specific issues brought up by the residents meant that it always felt more relevant and useful to the residents.

- Having a master teacher educator as the instructor meant she was able to constructively dissect her own practice as well as ask open ended questions to get the residents to think about their own reasons for reacting or acting in particular ways.

*Programmatic Elements*

- Asset-minded teaching and building relationships with students and families was highlighted as important early on, but did not become connected to content instruction.

- Every primary participant mentioned at some point how valuable it was to build relationships with students and their families. Some even expressed difficulty working with the methods’ field experiences in comparison to their residency sites because they didn’t have as much understanding about who the students were or where they were coming from.
The importance of relationship building was particularly clear after residents had all been in charge of teaching at least one class on a regular basis (more was said about this in the exit interviews than in the post-conference interviews).

- Some residents had a hard time figuring out the capabilities of their students and often got caught up in being concerned more about management than content wherein they reduced rigor perhaps because they thought over-scaffolding would reduce negative behaviors.

**Limitations**

As a multiple case study with cross case analyses, this study has several limitations to the strength of my assertions and their generalizability to contexts outside of the residency I observed. First, there are all the typical weaknesses of case studies, such as small sample size and limited quantified results. However, given the diversity of mentor-mentee dyads I was able to work with and the multitude of shared experiences by my participants, this study represents a unique look at the idiosyncrasies that highlight features of the preservice teacher experience that will stand up to future scrutiny. One way I have tried to balance my bias as the sole researcher is to share my general findings with my participants. They were provided copies of part of their case studies (those from Phase 1 in Chapter 4) and a shortened version of the section on my assertions (above) and asked for their input, particularly if they felt the material aligned with their recollections.
and experiences. They were additionally provided the definitions I used for the noticing practices and orientation categories (the document each resident received opened with Tables 5 and 6 and ended with summaries of the assertions made). None of the primary participants indicated they thought anything was amiss, and most did not provide any additional feedback. Anthony mentioned something while I was writing this conclusion that I have since addressed in my assertions above, but did not change my analysis or conclusions at all. Instead, his suggestion provides another argument for helping our preservice teachers learn to focus on student ideas about content as the primary goal of being in the classroom, with management skills selected to support this goal. As the residents were still in the midst of full-time student teaching at the time of this writing, it is unsurprising that they were limited in their feedback. I am very appreciative for the time that they could provide my work.

A second limitation is in the sheer amount of data I had at my disposal. I will require much more time to devote the attention needed to fully analyze every piece of data I collected. In order to respect my own time and stay focused on the original goals of this study, I limited the coding schemes I used for a lot of my data. I left behind virtual markers for additional analysis, which I hope to have an opportunity to address at a later date. The fact that I had worked closely with the residency in question previously provided me a lot of insight I might not otherwise have had, but also provided an additional bias to my analysis and data collection. This is, in itself, a third limitation. To reduce the bias in my data collection and analysis would require research assistants who
are trained to collect similar data from observations and interviews, and then code overlapping sets of data.

Finally, I realize there are other limitations to this work. However, I have done my best to provide a rich description of the residency experiences of several preservice teachers with as much curiosity and open-mindedness about learning to teach. My participants were all quite forthcoming and open to my presence. Although my intention was to be as much an observer as possible, the fact that my participants all took my presence to be educational and useful means that I was a participant-observer. This is a major limitation, but also afforded me opportunities to which I might not have otherwise had access. For example, residents freely shared with me their struggles, hopes, and ideas. I never felt as though anyone was purposefully trying to convince me to believe something they felt to be untrue. Some participants also expressed curiosity in my process, asking questions and thinking “out loud” about their own learning process.

**Future Research**

This dissertation is merely the beginning of a much larger research plan. Throughout this process, I have made note of multiple additional questions and possibilities. I look forward to investigating as many as I can. Below are a few suggestions for research questions and studies into how to improve preservice teacher learning in science and mathematics.

Originally I had thought I wanted to look into the relationship between emotional states during teacher education field experiences and uptake of certain pedagogical
practices. However, I realized I needed to first know whether or not relevant experiences were occurring and to decide on a pedagogic practice to study. This is where this current study fills in a gap for me. Now that I have a better sense of the types of interactions that come into play between mentors and mentees, and that noticing practices have seemingly relevant adjacent practices that are worth examining further, I would like to dig deeper into the relationships between mentors and mentees. For example, I would like to perform a study on emotions and decision making/learning during the residency experience—specifically, the feedback loop between affect and learning. Emotions are an important part of decision making, and therefore teaching and learning (Pekrun, 1992, 2006). Given the importance of the relationships between mentors and mentees, I would like to examine more closely the smaller moments that occur between mentor and mentee and see how the emotional impact of interactions relates to what residents determine is important and focus on.

Similarly, I would like to delve more deeply into the specific communication methods of strong versus weak mentor-mentee dyads and the influence of the coach or other support systems. Part of this research would include the development and implementation of a coach training plan to help coaches shift mentors from role models to teacher educators. A related alternative would be to use mentor training to improve their roles as teacher educators specifically around examining and responding to student work. There is a significant body of research examining the impact of university educators using video to support the development of noticing skills in preservice
teachers, however, I would like to explore more place-based methods to capitalize on the opportunities afforded by working in schools alongside cooperating teachers. One way to do this could be to incorporate lesson study-like designs or focused reflective practices that use real student work to make decisions as close to real time as possible.

Regardless of what my next project will be, I know there is a lot left to learn about the development of preservice teachers, particularly in reference to key practices for responsive teaching. Given the high degree of focus on behaviors and superficial concerns in classrooms, yet little improvement in long-term learning or academic success for our most underserved students, it is important that we shift our focus to content understanding. My work suggests that mentors who are able to systematically break down and support the use of student ideas to direct instruction can pass this skill on to their mentees. Therefore, if teacher education programs can find ways to systematically discuss and teach about content understanding and adapting instruction to the abilities and needs of specific students, we may be able to improve instruction for all.
BIBLIOGRAPHY


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https://doi.org/10.3102/0028312028001063

https://doi.org/10.3102/0034654311423382


https://doi.org/10.3102/0013189X015002004


https://doi.org/10.1177/0022487114560908

APPENDIX A

IRB FORMS AND APPROVALS

Note: Final district approval was received and filed with Temple University IRB in September of the study year, after securing consent from participants and their school building leadership. Initial district approval was received the prior November. Years and school district information have been redacted to maintain confidentiality.
The IRB approved the protocol 24780.

If the study was approved under expedited or full board review, the approval period can be found above. Otherwise, the study was deemed exempt and does not have an IRB approval period.

If applicable to your study, you can access your IRB-approved, stamped consent document or consent script through ERA. Open the Attachments tab and open the stamped documents by clicking the Latest link next to each document. The stamped documents are labeled as such. Copies of the IRB approved stamped consent document or consent script must be used in obtaining consent.

Before an approval period ends, you must submit the Continuing Review form via the ERA module. Please note that though an item is submitted in ERA, it is not received in the IRB office until the principal investigator approves it. Consequently, please submit the Continuing Review form via the ERA module at least 60 days, and preferably 90 days, before the study's expiration date.

Note that all applicable Institutional approvals must also be secured before study implementation. These approvals include, but are not limited to, Medical Radiation Committee ("MRC"); Radiation Safety Committee ("RSC"); Institutional Biosafety Committee ("IBC"); and Temple University Survey Coordinating Committee ("TUSCC"). Please visit these Committees’ websites for further information.

Finally, in conducting this research, you are obligated to submit the following:

- Amendment requests - all changes to the study must be approved by the IRB prior to the implementation of the changes unless necessary to eliminate apparent immediate hazards to subjects
- Reportable new information - using the Reportable New Information form, report new information items such as those described in the Investigator Guidance: Prompt Reporting Requirements HRP.801 to the IRB within 5 days;
- Closure report - using a closure form, submit when the study is permanently closed to enrollment; all subjects have completed all protocol related interventions and interactions; collection of private identifiable information is complete; and Analysis of private identifiable information is complete.

For the complete list of investigator responsibilities, please see the Policies and Procedures, the Investigator Manual, and other requirements found on the Temple University IRB website: http://research.temple.edu/irb-forms-standard-operating-procedures#POLICY

Please contact the IRB at (215) 707-3390 if you have any questions.

Figure 4. Temple IRB letter.
Figure 5. Temple IRB modification approval letter #1.
Figure 6. Temple IRB letter of clarification.
Figure 7. Temple IRB modification approval letter #2.
Consent Form for Preservice Teachers

**Title of research:** Development of Professional Noticing Skills in Preservice Science

Updated research questions (clarified), added more details to interview guides, added compensation for participants, added an interview session, expanded timing of study to include Spring 2019, updated consent forms to match.

**Investigator and Department:** PI Dr. Janelle Bailey (advisor for Amity F. Gann), Department of Teaching & Learning, Temple University College of Education

**Why am I being invited to take part in this research?**

We invite you to take part in a research study because you are a member of the Teacher Residency cohort, Temple's Middle Grades Education Program, or Temple's TUteach program and are enrolled in teacher education courses in the College of Education.

**What should I know about this research?**

- Someone will explain this research to you.
- Whether or not you take part is up to you.
- You can choose not to take part now but later change your mind to participate.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

**Who can I talk to about this research?**

If you have questions, concerns, or complaints, or think the research has hurt you, contact Amity F. Gann, Department of Teaching & Learning, Temple University, 1301 Cecil B. Moore Ave., Ritter Annex 422, Philadelphia, PA 19122-6091, afgann@temple.edu.

This research has been reviewed and approved by an Institutional Review Board. You may talk to them at (215) 707-3390 or e-mail them at: irb@temple.edu for any of the following:

- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get information or provide input about this research.

**Why is this research being done?**

The purpose of the study will be to examine the processes by which preservice teachers learn how to interpret student thinking about science during teacher education programs specifically programs focused on the preparation of middle grades and/or secondary science teachers.

**How long will I be in this research?**
Protocol Template for Minimal Risk Studies not Regulated by FDA

We expect that you will be in this research study during the current semester (prior to your student teaching). The total time commitment for participation in this study will be a maximum of six hours above and beyond the normal class time.

**What happens if I agree to be in this research?**

Contact with the researcher (Amity Gann) will include:

- Six field-based observations
  - Including observation of your teaching and post-lesson discussion with mentor and/or coach
  - Observations will be of two adjacent lessons taught at each of three or four different points during the semester (for example, during the first third of semester, mid semester, last third of semester for semester-long field experiences or as available for those placed in intermittent field placements or during the student teaching semester)
- Five voice recorded interviews (one prior to starting field experiences, one after each block of observations, and one following completion of observations and interviews)
- Group observations during teacher education courses (e.g. science methods, reflective seminar, etc.) throughout the semester
- Sharing of teaching and learning artifacts during university-based class time

Artifacts collected may include lesson plans, lesson reflections, journal entries, homework assignments, class notes, Intermediate Performance Assessment, as well as the Teacher Observation Reports you receive.

**Note:** if you choose not to participate in this study, you may be in the presence of Amity Gann during observations of your classmates, however no observations or notes will be made of your activities.

**Will being in this research help me in any way?**

Taking part in this research may help you become more reflective and aware of effective instructional practice for science teaching. If you complete all requirements described above, you will receive a $100 gift card to Amazon.com in compensation for your time.

**Is there any way being in this research could be bad for me?**

Privacy risks are minimal but may include the disclosure of private educational information (see following section).

**What happens to the information collected for this research?**

To the extent allowed by law, we limit the viewing of your personal information to people who have to review it. We cannot promise complete secrecy. The IRB, Temple University and other representatives of these organizations may inspect and copy your information.

Your name and personal information will not be shared with anyone other than the PI and Co-PIs. Any results that are published will be anonymous and written to ensure your confidentiality. The original data files with names will be encrypted and password-protected. Any paper copies with names will have names blacked out or covered with...
opaque tape after an anonymous ID number is written on it. Any data with names will be destroyed one year after the study’s completion.
Upon request, a copy of the records disclosed will be provided to you.

**Signature Block for Adult Subject Capable of Consent**

Your signature documents your permission to take part in this research.

<table>
<thead>
<tr>
<th>Signature of subject</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed name of subject</td>
<td></td>
</tr>
<tr>
<td>Signature of person obtaining consent</td>
<td>Date</td>
</tr>
<tr>
<td>Printed name of person obtaining consent</td>
<td></td>
</tr>
</tbody>
</table>

Your signature below indicates your decision not to take part in this research.

<table>
<thead>
<tr>
<th>Signature of subject</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printed name of subject</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 8. Consent form for primary subjects.**
Title of research: Development of Professional Noticing Skills in Preservice Science Teachers

Investigator and Department: PI Dr. Janelle Bailey (advisor for Amity F. Gann, doctoral student), Department of Teaching & Learning, Temple University College of Education

Why am I being invited to take part in this research?
We invite you to take part in a research study because you are a member of the mentoring or coaching teams of [Redacted] Middle Grades Education Program, or [Redacted] program.

What should I know about this research?
- Someone will explain this research to you.
- Whether or not you take part is up to you.
- You can choose not to take part now but later change your mind to participate.
- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Who can I talk to about this research?
If you have questions, concerns, or complaints, or think the research has hurt you, contact Amity F. Gann, Department of Teaching & Learning, Temple University, 1301 Cecil B. Moore Ave., Ritter Annex 422, Philadelphia, PA 19122-6091, afgann@temple.edu.

This research has been reviewed and approved by an Institutional Review Board. You may talk to them at (215) 707-3390 or e-mail them at: irb@temple.edu for any of the following:
- Your questions, concerns, or complaints are not being answered by the research team.
- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research subject.
- You want to get information or provide input about this research.

Why is this research being done?
The purpose of the study will be to examine the processes by which preservice teachers learn how to interpret student thinking about science during teacher education programs at [Redacted] specifically programs focused on the preparation of middle grades and/or secondary science teachers.

How long will I be in this research?
We expect that you will be in this research study during the current semester. The total time commitment for participation in this study will be a maximum of 90 minutes above and beyond the normal field experience requirements.
Protocol Template for Minimal Risk Studies not Regulated by FDA

What happens if I agree to be in this research?

Contact with the researcher (Amity Gann) will include:

- Scheduling of observations and final interview
- Six field-based observations of your preservice teacher(s) and your interactions with them. These include:
  - Observation of their teaching and post-lesson discussion with you
  - Observations will be of two adjacent lessons taught at each of three or four different points during the semester (for example, during the first third of semester, mid semester, last third of semester for semester-long field experiences or as available for those placed in intermittent field placements and during student teaching, as determined at end of Fall semester)
  - Recording of interactions following observations
- One voice recorded interview after all observations of your preservice teacher are complete
- Collection of any written commentary you make on your preservice teacher’s lesson plans, Intermediate Performance Assessment, as well as the Teacher Observation Reports you complete, as applicable

Will being in this research help me in any way?

Taking part in this research may help you become more reflective and aware of effective instructional practice for science teaching and how to mentor future preservice science teachers. If you complete all requirements described above, you will receive a $50 gift card to Amazon.com in compensation for your time.

Is there any way being in this research could be bad for me?

Privacy risks are minimal but may include the disclosure of private educational information (see following section).

What happens to the information collected for this research?

To the extent allowed by law, we limit the viewing of your personal information to people who have to review it. We cannot promise complete secrecy. The IRB, Temple University and other representatives of these organizations may inspect and copy your information.

Your name and personal information will not be shared with anyone other than the PI and Co-PIs. Any results that are published will be anonymous and written to ensure your confidentiality. The original data files with names will be encrypted and password-protected. Any paper copies with names will have names blacked out or covered with opaque tape after an anonymous ID number is written on it. Any data with names will be destroyed one year after the study’s completion.

Upon request, a copy of the records disclosed will be provided to you.
Figure 9. Consent form for secondary subjects.
APPENDIX B

INTERVIEW PROTOCOLS

The following are the semi-structured interview protocols I used for this study. The TBI was designed to be conversational and then evaluated using the definitions provided by Luft and Roehrig, 2007.

I. Video-based noticing assessment used during Intake and Exit Interviews

Inspired by a “Noticing Task” by Meredith Houle Vaughn, Lauren Stewart, and Donna L. Ross - Presented at ASTE 1/6/18

Show video of classroom setting with students making sense of evidence and teacher leading. I used sections of https://vimeo.com/105201892 (Intake: 12:52-16:17; Exit: 7:15-9:56) with permission from Mark Windschitl.

1. What struck you or stood out about this video?
2. What stood out to you about what the students were saying and doing as they made sense of data?
3. What stood out to you about what the teacher was saying and doing as they were working with the students?

II. Primary participant interview questions for after each observation of their teaching

1. Overview Questions:
   a. Was there anything you had planned to do but changed as you taught your lesson?
   b. What did you learn about planning lessons from this activity?
   c. What did you learn about students and their learning from this activity?
   d. What do you think you need to do to help your students move forward and be better prepared to ___________?
   e. If you were going to teach this lesson again, what would you do differently? Why?

2. Let’s talk about some specific moments during your teaching your first lesson. I will provide you a couple of examples of situations that occurred and would like your input on what was going on during these times.
   - Example 1:
     When you asked students (fill in example)
     Students said something like: (paraphrase student(s) to give enough of a cue to remind teacher about how they responded)
     Do you remember how you responded?
     If yes: Why did you respond this way? What did you hope to get out of this interaction?
If no: You followed up by… (provide overview of response or direct quote if available)
Why did you respond this way? What did you hope to get out of this interaction?
Where did you learn to do this?
Can you think of another way to respond to this student/situation?
(If not, provide an alternative option that includes responding through deepening exploration and ask what they think of this other option.)

- Example 2: (Repeat process from example 1 for a new situation)
  When you asked students (fill in example)
  Students said something like: (paraphrase student(s) to give enough of a cue to remind teacher about how they responded)
  Do you remember how you responded?
    If yes: Why did you respond this way? What did you hope to get out of this interaction?
    If no: You followed up by… (provide overview of response or direct quote if available)
    Why did you respond this way? What did you hope to get out of this interaction?
    Where did you learn to do this?
    Can you think of another way to respond to this student/situation?
    (If not, provide an alternative option that includes responding through deepening exploration and ask what they think of this other option.)

3. Did they understand the idea of (objective of lesson)? How do you know? How can you know?
4. Was there anything that caught you off guard during your lesson? What did you do and why?
Reference an example of when they appeared to change course:
What made you decide to change how you were teaching?
What were you hoping to do by changing this tactic (ex: from unstructured exploration to structured)?
5. Scientific practices:
- When planning your lesson, how did you think about incorporating scientific practices?
- What did your students learn about scientific practices from the lesson you taught today?
- What do you think the scientific process looks like in classrooms? (Ideally and realistically)
6. Now that you have taught (n/several) lesson(s):
- How do you think you can know when a student understands the topic you are teaching?
- What can you do to encourage students to deepen their understanding of the material you are covering?
• How did you learn to teach?
• So far, what do you think has been the most useful source of information about teaching and learning? Why?

At the start of this interview, we talked about what you learned while teaching this lesson. Do you have anything else to add? (Original questions were: Was there anything you had planned to do but changed as you taught your lesson? What did you learn about planning lessons from this activity? What did you learn about students and their learning from this activity? What do you think you need to do to help your students move forward and be better prepared to ________? If you were going to teach this lesson again, what would you do differently? Why?)

III. Questions from the Teacher Belief Interview protocol modified from Luft and Roehrig (2007), used during Intake and Exit Interviews

1. How do you imagine you would/do you maximize student learning in your classroom?
2. How would/do you describe your role as teacher?
3. In the school setting, how would/do you decide what to teach and what not to teach?
4. How would/do you decide when to move on to a new topic in your class?
5. How would/do your students learn science/math best?
6. How would/do you know when learning is occurring in your classroom?
7. How would/do you know when a student understands the material you are teaching?

IV. Interview questions for secondary participants during Exit Interviews

1. How would you characterize your student teacher’s ability to assess student thinking?
2. When does your student teacher typically think about and address student thinking?
3. What techniques does your student teacher typically use to assess student thinking?
4. How much do you think you have influenced how your student teacher approaches student thinking? What have you done to help them think about student thinking?
5. How does your student teacher maximize student learning in your classroom?
6. What do you think your student teacher needs to work on in terms of addressing student thinking?
APPENDIX C

CODEBOOK

Note: The following are codes used when analyzing artifacts, interviews, and field notes. Themes were generated from grouping together related-seeming codes. Notes are definitions or clarifications where the code was insufficiently specific.

Table 9. Codebook.

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Noticing</td>
<td>Tends to focus on behaviors and management. Students are either participating in their learning or not.</td>
<td>Noticing</td>
</tr>
<tr>
<td>Low Attending</td>
<td>Teacher pays attention to behaviors (academic and non-academic). If they ask a question, it is factual and specific to the task at hand, whether social or academic.</td>
<td></td>
</tr>
<tr>
<td>Low Interpreting</td>
<td>Resident decodes student idea and makes a judgment about what the student means in terms of accuracy.</td>
<td></td>
</tr>
<tr>
<td>Low Responding</td>
<td>Resident gives a yes or no type response to a student question or addresses a problem by providing the answer or giving directions that directly point at an answer.</td>
<td></td>
</tr>
<tr>
<td>Moderate Noticing</td>
<td>Tends to focus on accuracy of student responses. Measures of student participation hinge upon whether they are correct or not.</td>
<td></td>
</tr>
<tr>
<td>Moderate Attending</td>
<td>Elicits student ideas that are explanatory in nature and not merely a simple yes/no/regurgitation (could be somewhat open ended but directly related to task at hand)</td>
<td></td>
</tr>
<tr>
<td>Moderate Interpreting</td>
<td>Resident identifies the accuracy of a student’s response, but also can describe the meaning behind the response, but only in terms of being directly related to the current lesson goal.</td>
<td></td>
</tr>
<tr>
<td>Moderate Responding</td>
<td>Moves on to next part of class (per lesson plan), but references previous questions or addresses issues later</td>
<td></td>
</tr>
<tr>
<td>High Noticing</td>
<td>Looks deeper at how students think about material and the reasons behind their responses. Plans for or addresses student misconceptions. Student thinking is primary.</td>
<td></td>
</tr>
<tr>
<td>High Attending</td>
<td>Asks specific questions to elicit student explanations or detailed responses. Questions are specifically about the content and tend to be open ended.</td>
<td></td>
</tr>
<tr>
<td>High Interpreting</td>
<td>Resident identifies a student misconception or makes a connection to a previous explanation a student gave. Looks for deeper meaning behind responses in terms of connecting beyond the current class purposes or goals.</td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Notes</td>
<td>Theme</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>High Responding</td>
<td>Asks probing questions that ask student to explain more or go deeper and make connections OR Changes direction or probes in such a way to specifically address misconceptions or lack of depth of response.</td>
<td>Noticing (continued)</td>
</tr>
<tr>
<td>Beliefs about learning</td>
<td>Different ideas about what it means to learn</td>
<td>Beliefs about Learning</td>
</tr>
<tr>
<td>Discuss issues related to learning - broadly</td>
<td>Talks about or mentions theories and experiences that inform their ideas about learning. Can also be concern about recent events or questions about impact of different influences on student opportunities to learn</td>
<td></td>
</tr>
<tr>
<td>Learning means being able to apply to a new situation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning means being able to explain to others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning means making connections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student centered teaching, as a goal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asking questions</td>
<td>Takes time to ask for details or explanations about teacher choices related to noticing</td>
<td>Observing Noticing Skills in Others</td>
</tr>
<tr>
<td>Deep noticing of teacher moves</td>
<td>Mentions several things teacher did or goes into some detail about how the teacher was teaching, including some reasoning into why the teacher did what they did or examined the sequence of what the teacher did. Mainly focused on what the teacher is doing to elicit student ideas and how they respond to student answers/questions.</td>
<td></td>
</tr>
<tr>
<td>Moderate noticing of teacher moves</td>
<td>Mentions something a teacher did, but mainly focused on behaviors or general trend of what teacher is doing. Related to student thinking, but could be behavioral.</td>
<td></td>
</tr>
<tr>
<td>Notices how others elicit student thinking</td>
<td>Looks at questions and assignments</td>
<td></td>
</tr>
<tr>
<td>Notices how others respond to student thinking</td>
<td>Describes or interprets teacher responses</td>
<td></td>
</tr>
<tr>
<td>Notices reflection modeled by others</td>
<td>Resident notes that a mentor, teacher, peer, etc., reflects on own work</td>
<td></td>
</tr>
<tr>
<td>Opportunity to attend, modeled by others</td>
<td></td>
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</tbody>
</table>
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity to interpret student idea or action, modeled</td>
<td>Given a task or situation to consider that involves exploring student work and interacting with students around their work</td>
<td>Observing Noticing Skills in Others (continued)</td>
</tr>
<tr>
<td>Opportunity to learn to engage student thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity to respond, missed by resident</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunity to respond, modeled by other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reflects on teacher's choice of action or reaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Superficial noticing of teacher moves</td>
<td>Notes broadly what teacher does but doesn’t make a mention of meaning, purpose, or value to teaching</td>
<td></td>
</tr>
<tr>
<td>Connects to academic, but not content, skills or knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverse learners</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inclination to reduce rigor out of concern for students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References student work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student ability, High expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student ability, lowered expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student ability, rising expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student ability, surprised at how diverse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>References student work</td>
<td></td>
<td></td>
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<tr>
<td>Student ability, High expectations</td>
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<tr>
<td>Student ability, rising expectations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student ability, surprised at how diverse</td>
<td></td>
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</tr>
</tbody>
</table>

Interest in Student Potential or Ability
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student ability, surprised by or caught off guard</td>
<td></td>
<td>Interest in Student Potential or Ability (continued)</td>
</tr>
<tr>
<td>Student behavior, academic or engagement</td>
<td></td>
<td>Reflective Practices</td>
</tr>
<tr>
<td>Connects to other content terminology (e.g., science in math or math in science)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects to own students or classroom</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects to prior knowledge of content (math or sci)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects to schools generally</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connects to students broadly, not specific to own students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep Reflection</td>
<td>Provides <em>details</em> to illuminate their thought process or how they see this idea connect to other ideas/experiences.</td>
<td></td>
</tr>
<tr>
<td>Doesn't extend beyond scope of class discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engages with material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extends beyond course material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formative assessment addressed</td>
<td>FA is mentioned in some way, possibly as a plan of action or pointing out something that has been done to access student ideas at a particular time prior to end of unit</td>
<td></td>
</tr>
<tr>
<td>Had opportunity, barely appeared to take advantage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interprets outside of class (reflection)</td>
<td>Describes learning as being able to be correct or incorrect. Little to no discussion of complex problem solving.</td>
<td>Reflective Practices (continued)</td>
</tr>
<tr>
<td>Lesson planning Making sense of curricula Interprets outside of class (reflection)</td>
<td>Examines curriculum-based problems for utility or meaning in terms of supporting student learning</td>
<td></td>
</tr>
<tr>
<td>Learning goals for students are somewhat superficial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lesson planning Making sense of curricula</td>
<td>Examines curriculum-based problems for utility or meaning in terms of supporting student learning</td>
<td></td>
</tr>
<tr>
<td>Like eliciting, but upon reflection Like responding, but upon reflection Looking to future Make connections to other content or experiences Missed opportunity Motivation Opportunity to notice is idealized Rationalizing their observations Responding, thinking about how Responding, upon reflection Skepticism over methods used</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

295
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superficial connection to purpose of university course</td>
<td>Mentions a previously covered topic, but doesn’t go on to provide a rational or any reasoning about the meaning behind the connection</td>
<td>Reflective Practices (continued)</td>
</tr>
<tr>
<td>Superficial Reflection</td>
<td>Mentions a connection to an experience or something learned in class, but doesn’t go into any detail.</td>
<td></td>
</tr>
<tr>
<td>Teacher attending, academic Teacher attending, behavior Uncertain what else to do Using Resources</td>
<td>Resources (such as from the program, coursework, peers, mentors, coaches, etc.) which provide input, feedback, material resources, etc. to the subject.</td>
<td></td>
</tr>
<tr>
<td>Advice on Noticing from others</td>
<td></td>
<td>Seeking Feedback From Knowledgeable Others</td>
</tr>
<tr>
<td>Takes practice to learn to notice Coach as support Coach example Coach input</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviewer provides suggestion Responds well to interviewer suggestion Mentor Influence Mentor example Mentor finds it hard to unpack Mentor input</td>
<td>Coach is referenced as source of information critique OR was actively engaging in providing info or feedback</td>
<td></td>
</tr>
<tr>
<td>Personal style vs mentor's style Peer support Professor input</td>
<td></td>
<td>Reaching out to a peer for suggestions or commiseration</td>
</tr>
</tbody>
</table>
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pushed to increase rigor</td>
<td></td>
<td>Seeking Feedback From Knowledgeable Others (continued)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Staff opinions</td>
<td>Concern over what other teachers think about school or student related topics OR an observation about the ability of staff to make an informed decision or opinion</td>
<td></td>
</tr>
<tr>
<td>University Courses</td>
<td>Back off to give students room to think</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content-related item that can be noticed in future</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teaching theory is unrealistic, irrelevant, or inaccurate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Theory seems useful and will improve teaching</td>
<td></td>
</tr>
<tr>
<td></td>
<td>University Course, opportunity to Take notes on relevant topic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Background Knowledge &amp; Experience</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Admits unfamiliar with material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Doesn't realize what they don't know</td>
<td></td>
</tr>
<tr>
<td></td>
<td>First time working with middle schoolers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>References prior Coursework or teaching experience</td>
<td></td>
</tr>
</tbody>
</table>

Content knowledge and background knowledge
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom management</td>
<td>Relates to classroom or student behaviors - can be a request for help or a description of a behavior or even a plan for building better student behaviors (grit). Also includes involvement in maintaining routines/expectations.</td>
<td>Content knowledge and background knowledge (continued)</td>
</tr>
<tr>
<td>Positive reinforcement</td>
<td></td>
<td>Classroom Management</td>
</tr>
<tr>
<td>Student behavior, non-academic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curricular issues</td>
<td>Concerns about topics covered or ideas relating to what is taught broadly</td>
<td>Curricular Issues</td>
</tr>
<tr>
<td>Amount of material</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discourse</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus on content not practices despite asked about practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Literacy skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Content knowledge goals in math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math content, learning for understanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematical habits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math practices</td>
<td>Includes experimenting - processes used by mathematicians or others to do math effectively and creatively</td>
<td></td>
</tr>
<tr>
<td>Mathematical Structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Some mathematical habits the residents came up with on their own and were not explicitly provided, like perseverance or grit.</td>
<td></td>
</tr>
<tr>
<td>Using Precision</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of Mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance to student lives (math)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content knowledge goals in science</td>
<td></td>
<td>Curricular Issues (continued)</td>
</tr>
<tr>
<td>Depth of scientific thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ideal ways to learn science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature of Science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevance to student lives (science)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science content (not practices)</td>
<td>Can be a crosscutting concept or a disciplinary core idea</td>
<td></td>
</tr>
<tr>
<td>Science content, learning for understanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science practices</td>
<td>Asking Questions and Defining Problems Developing and Using Models</td>
<td>Broadly: Larger issues in education (needs further unpacking) and</td>
</tr>
<tr>
<td></td>
<td>Planning and Carrying Out Investigations Analyzing and Interpreting</td>
<td>Assessments</td>
</tr>
<tr>
<td></td>
<td>Data Using Mathematics and Computational Thinking Constructing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Explanations and Designing Solutions Engaging in Argument from</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence Obtaining, Evaluating, and Communicating Information</td>
<td></td>
</tr>
<tr>
<td>Grappling with issues related to urban education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>challenges</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Racial awareness</td>
<td>Comments about racial issues, their own journey, or other race-</td>
<td></td>
</tr>
<tr>
<td>Relationships with students</td>
<td>related concerns</td>
<td></td>
</tr>
<tr>
<td>Being a child or teen</td>
<td>Actions that help or show that the resident learn about their</td>
<td></td>
</tr>
<tr>
<td>Knowing students well</td>
<td>students</td>
<td></td>
</tr>
<tr>
<td>Relatable content</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding where kids are at</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role of Teacher</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being a role model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formative Assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Code</td>
<td>Notes</td>
<td>Theme</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>One on one help</td>
<td>Worked with a single student to help them (or maybe two, but still highly focused tutoring)</td>
<td>Broadly: Larger issues in education (needs further unpacking) and Assessments</td>
</tr>
<tr>
<td>Summative assessment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as facilitator,</td>
<td>Teacher’s role or action is related to motivating students to do work or behave a certain way</td>
<td></td>
</tr>
<tr>
<td>academic ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as facilitator, group dynamics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as facilitator, student behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as facilitator, student tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher as motivator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher behavior, academic</td>
<td>Relating to teaching or doing something that is more about classroom culture or expectations</td>
<td></td>
</tr>
<tr>
<td>Teacher behavior, non-academic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher modeling science practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching, procedural</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student actions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing science</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading students physicality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student behavior, academic</td>
<td>Unspecified student academic behaviors referenced</td>
<td></td>
</tr>
<tr>
<td>Students explaining concepts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students referencing data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students using resources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 9. (continued)

<table>
<thead>
<tr>
<th>Code</th>
<th>Notes</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awareness of larger issues in teaching</td>
<td>May be an awareness of all the different roles and duties, but also could be an awareness of challenges and hazards</td>
<td>Broadly: Larger issues in education (needs further unpacking) and Assessments</td>
</tr>
<tr>
<td>High awareness</td>
<td>Detailed and accurate accounting of depth of concerns related to teaching</td>
<td></td>
</tr>
<tr>
<td>Low awareness of issues</td>
<td>Not aware there are multiple concerns</td>
<td></td>
</tr>
<tr>
<td>Moderate awareness</td>
<td>Shows there are multiple concerns for teachers, but appears to only have a vague understanding of these (unspecified or very broadly described)</td>
<td></td>
</tr>
<tr>
<td>Concern over access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Factor, Trauma Expectation vs reality</td>
<td>Traumatic events in school community (that may impact learning or relationship building)</td>
<td></td>
</tr>
</tbody>
</table>
# APPENDIX D

## RESIDENCY GRADUAL RELEASE PLAN

Note: The following was taken from the [MA] residency handbook for the study year. P-TOR, TOR, PDE refer to the Formal Observations and evaluations made by coaches.

<table>
<thead>
<tr>
<th>Month</th>
<th>Activities</th>
</tr>
</thead>
</table>
| Sept. | Get to know students, teachers, school community  
Learn school policies, layout, routines, procedures, and schedules  
Review all school and district/charter policy documents and handbooks  
Take attendance and learn all students' names  
Learn how to use technology tools in your classroom  
Assist in organizing and preparing classroom materials/handouts  
Establish daily arrival and departure times  
Establish regular weekly co-planning time and reflection time  
Participate in meetings (grade, subject, school-wide, etc.) with the Mentor  
Observe classroom environment, management strategies, and teacher-student interactions  
Use protocols while observing and de-brief with Mentor  
Co-planning; Mentor is the lead; introduces Resident to all aspects of planning  
Co-teaching Strategies to use: 1) One Teach, One Observe, 2) One Teach, One Assist  
*Resident receives informal feedback from Mentor daily and during weekly planning/reflection times and coach (one P-TOR)* |
| Oct.  | Continue September responsibilities  
Observe pedagogical techniques, particularly those being taught in your methods courses  
Observe and use informal/formal assessments and resulting data  
Co-planning; Mentor is the lead; Resident supports and contributes ideas/resources/strategies  
Co-teaching Strategies to use: 1) One Teach, One Observe, 2) One Teach, One Assist, 3) Parallel Teaching, 4) Station Teaching, 5) Team Teaching  
*Resident receives formal feedback from the Mentor (Mentor Feedback Form) and formal feedback from the Coach (two P-TORs)*  
*Resident receives informal feedback from Mentor daily and during weekly planning/reflection times* |
| Nov.  | Continue previous months' responsibilities  
Observe questioning strategies, pacing, and transitions  
Co-planning: Resident starts to construct lesson plans collaboratively with Mentor; Mentor provides guidance/feedback and resources (e.g., lesson objectives, standards, curricular resources)  
Co-teaching Strategies to use: 1) One Teach, One Observe*, 2) One Teach, One Assist*, 3) Parallel Teaching, 4) Station Teaching, 5) Team Teaching, 6) Alternative Teaching, 7) Supplemental Teaching *Roles start to switch*  
*Resident receives formal feedback from the Mentor (Mentor Feedback Form)* |

Figure 10. Program gradual release plan.
| Dec. | Continue previous months' responsibilities  
|      | Co-planning: Resident continues to construct lesson plans collaboratively with Mentor; Mentor provides guidance/feedback and resources (e.g., lesson objectives, standards, curricular resources)  
|      | Co-teaching Strategies to use: 1) One Teach, One Observe, 2) One Teach, One Assist, 3) Parallel Teaching, 4) Station Teaching, 5) Team Teaching, 6) Alternative Teaching, 7) Supplemental Teaching  
|      | Resident receives formal feedback from Mentor (Mentor Feedback Form) and formal feedback from the Coach (one P-TOR)  
|      | Resident receives informal feedback from Mentor daily and during weekly planning/reflection times |

| Jan.  
| Feb.  | Continue previous months' responsibilities  
|      | Co-planning continues: Resident transitions to lead; Mentor transitions to support  
|      | By the second week in January, Resident assumes the lead for co-planning and co-teaching at least one math/science class on a daily basis  
|      | For the rest of January and February Resident should be leading 50% of the math/science classes (2-3 periods) on a daily basis  
|      | Co-teaching Strategies to use: 1) One Teach, One Observe, 2) One Teach, One Assist, 3) Parallel Teaching, 4) Station Teaching, 5) Team Teaching, 6) Alternative Teaching, 7) Supplemental Teaching  
|      | Resident receives formal feedback from Coach (two TORs)  
|      | Resident receives formal feedback from Mentor (Mid-Semester Evaluation)  
|      | Resident receives informal feedback from Mentor daily and during weekly planning/reflection times  
|      | Residents participate in Learning Rotations |

| Mar.  
| Apr.  | Continue previous months' responsibilities  
|      | Co-planning: Resident is the lead; Mentor is the support  
|      | During March-April, Resident assumes the lead for co-planning and co-teaching at least 75% of the math/science classes or more (roughly 4 periods)  
|      | Co-teaching Strategies to use: 1) One Teach, One Observe, 2) One Teach, One Assist, 3) Parallel Teaching, 4) Station Teaching, 5) Team Teaching, 6) Alternative Teaching, 7) Supplemental Teaching  
|      | Resident receives formal feedback from Coach (two TORs, two PDE 430s) |

|      | Resident receives formal feedback from Mentor (End-of-Semester Evaluation)  
|      | Resident receives informal feedback from Mentor daily and during weekly planning/reflection times |

Figure 11. (continued)