AN ABSTRACT OF THE DISSERTATION OF

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Title: Teacher Candidates' Noticing of Instructional Features in the Context of an Ambitious Mathematics Teacher Education Program.

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Rebekah L. Elliott

Teacher noticing is a necessary skill in order for teachers to elicit and respond to their students' mathematical ideas and support the ambitious learning goals of school mathematics. The purpose of this dissertation is to investigate what teacher candidates noticed about their teaching as they were provided supports and opportunities to develop skills with ambitious instruction during a mathematics teacher preparation program. Previous research on teacher noticing suggests that teacher candidates are challenged to notice student thinking and how instructional interactions unfold in a classroom. The focus of this study was to examine how teacher candidates' reflections attended to the interactions among the teacher's instruction, students' participation, and mathematical content within the instructional system. The research questions driving this study were: (1) What did teacher candidates most frequently notice when they analyzed their teaching? (2) What were the patterns of teacher candidates' noticing within and across four written reflections? and (3) How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?

Eleven teacher candidates enrolled in mathematics methods courses participated in the study. During the teacher education coursework, teacher candidates developed skills with ambitious teaching by working on four lessons, called *instructional activities (IAs)*, organized around high leverage teaching practices. These practices provide equitable opportunities for students to engage in authentic tasks of the discipline. During the enactment of these activities with students, teacher candidates' classroom teaching was videotaped. After each enactment, teacher candidates watched the video recording of their classroom teaching and composed a reflection structured by a set of questions. The reflection questions guided them to analyze their use of high leverage teaching practices within the context of the instructional

system and reflect on their successes and challenges in teaching ambitiously. Four reflections from each candidate were used as data sources for this study.

Results from analyses of these written reflections reveal that teacher candidates frequently and consistently focused on the topic of the teacher's instruction than other topics across reflections. Teacher candidates more frequently and consistently used evidence in their reflections. Teacher candidates increased their attention to the interaction of the teacher, student, and content over time from reflections one to three. Also, their attention to the interaction of the teacher, student, and content was more consistent over time from reflections one to three. Similarly, teacher candidates' taking of an interpret stance increased and was more consistent from reflections one to three. In addition, when teacher candidates interpreted teaching, they tended to equally focus on the topics of teacher's instruction and students' participation. As they interpreted teaching, teacher candidates mostly included evidence and paid attention to the interaction of the teacher and student and the interaction of the teacher, student, and content.

From syntheses of these results, I found that when teacher candidates analyzed teaching, they frequently and consistently noticed important moments in their instruction. They interpreted the teaching with the use of evidence to support their interpretation. Teacher candidates' noticing of classroom teaching increased the complexity over time. This was shown in the increasing of their attention to the interaction of the teacher, student, and content. Even though offer teaching alternative was reported as a stance with a positive relationship to teacher candidates' interpretation and attention to the interaction of teacher, student, and content, teacher candidates rarely attended to offering teaching alternative.

These results and findings suggest the use of videotapes of IA enactments as a possible approach to supporting teacher candidates' learning to notice the interactions of instructional features. They also suggest the effectiveness of using prompts to guide teacher candidates to focus on the topic of teacher's instruction, use evidence, pay attention to the interactions instructional features, and interpret teaching. Importantly, they suggest the necessity of prompts guiding teacher candidates to offer teaching alternative.

Additionally, the results and findings suggest the implications for future studies. Longitudinal studies could be conducted in order to explore the change and development of teacher candidates' noticing over time. The qualitative methods could be employed in order to get insights about what and how teacher candidates notice. A subset of teacher candidates in my study could be selected as a focus group to obtain more details about what and how they notice.

Teacher Candidates' Noticing of Instructional Features in the Context of an Ambitious Mathematics Teacher Education Program

by
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I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Sasiwan Maluangnont, Author

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Chapter 1

Introduction

In this introduction chapter, I describe issues in mathematics education that made me interested in doing this research and briefly explain my study. The chapter is divided into four sections. The first section, framing the problems, describes the problems that drew my attention to the development of mathematics teacher candidates' noticing of instructional features in a teacher education program. I briefly explain the study, which was based on these problems, in the second section. In the third section, I summarize the research questions that were addressed in the study. The last section describes the importance of the proposed study.

Framing the Problems

Mathematics education reform requires teachers to support and build upon students' mathematical ideas (National Council of Teacher of Mathematics [NCTM], 2000; NCTM, 2014). Teachers are expected to productively facilitate student discourse in ways that allow them to carefully listen to their ideas and continually adapt teaching based on students' thinking and difficulties. Facilitating students' participation in classrooms in this way is what educators and policymakers call *ambitious teaching*, with the intent being that every student develops mathematical proficiency (Lampert, Boerst, & Graziani, 2011; National Research Council [NRC], 2001). Ambitious teaching aims for each student, across ethnic, linguistic, and socioeconomic backgrounds, to learn authentic mathematics.

To appropriately respond to students' ideas and to teach ambitiously, teachers need the ability to systematically see and understand particular classroom situations. This kind of the seeing and interpreting of instruction has been called *professional vision* (Goodwin, 1994; Sherin, 2001). Teachers with professional vision are able to *notice*[1] significant moments in the classroom and *interpret* those moments. They also use their interpretations of specific classroom phenomena to make decisions based on the accounts of the instructional system: a teacher's

[1] A more elaborated definition of the term *noticing* will be provided in chapter two. For now noticing shall be understood as abilities to see and interpret significant classroom situations.

instruction, students' participation, and mathematical content (Lampert, 2001). In other words, noticing and interpreting skills are important for teaching because they support teachers in considering the instructional system for informing pedagogical decisions (Mason, 2011).

Teachers with different pedagogical expertise tend to notice and interpret classroom situations differently. When they identify significant moments, teachers with more pedagogical expertise are able to interpret instruction using a more complicated view of teaching that includes connections to the instructional system (Berliner, 1987, 1994; Ball & Cohen, 1999; Hammerness, Darling-Hammond, Bransford, Berliner, Cochran-Smith, McDonald, & Zeichner, 2005). In contrast, those with less pedagogical expertise—for instance, teacher candidates[2] who are new to the profession—mainly see and understand individual instructional features, especially teachers' instruction, with less connection among the critical aspects of teaching and learning. Researchers examining teacher candidates' noticing suggest that teacher education experiences are important for developing candidates' noticing skills (Santagata & Angelici, 2010; Star, Lynch, & Perova, 2011).

A variety of approaches may help teachers and teacher candidates to develop noticing abilities (Sherin & van Es, 2003). Numerous researchers have found the use of video records of classroom teaching to be a productive means for supporting teachers and teacher candidates in learning to notice. Video provides the additional benefits of offering a broader range of interactions among the teacher, students, and mathematical content (Santagata & Guarino, 2011; Sherin & van Es, 2009; Star, Lynch, & Perova, 2011). Further, it allows for stopping and reviewing significant moments that may help teachers and teacher candidates to better see interactions in classrooms (LeFevre, 2004; Sherin, Linsenmeier, & van Es, 2009).

While watching video, teacher candidates may learn to engage in an important process of learning to notice called *reflection*, a process of reasoning about instructional interactions that are meant to build an understanding of the complexity of the teaching-learning process (Schon, 1982). Engaging in reflection offers teacher candidates opportunities to notice teaching practice and instructional features—teacher, student, and content—and to consider decisions about future actions. Teacher candidates who learn to notice by engaging in reflection not only learn to notice and interpret instructional events but also they develop conjectures about working instructional plans and learn to act in new ways (Mason, 2011; Santagata & Angelici, 2010).

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[2] The term *teacher candidate* will be used throughout this dissertation to refer to individuals who are studying in teacher preparation programs.

Several studies on learning to notice from classroom video records engage teacher candidates in reflection. These studies support teachers in noticing students' thinking (van Es, 2011; Santagata, Zannoni, & Stigler, 2007). However, students' thinking is just one of the elements in the complex interactions among teacher, student, and content that takes place in mathematics instruction. Other researchers have suggested that teacher candidates need to pay attention to teachers' instruction, classroom environment, students' actions, and mathematical content in order to attend to the complexity of classroom instruction (Moore-Russo & Wilsey, 2014; Star & Strickland, 2008). They contend that learning to notice just one feature of mathematics instruction is insufficient. The studies advanced by Moore-Russo and Wilsey (2014) and by Star and Strickland (2008) suggest that learning to notice in a way that focuses on relationships among instructional features needs to be further studied. Thus, a study that emphasizes the noticing of relationships among teacher's instruction, students' participation, and mathematical content in mathematics instruction is needed in the field.

The Study

This dissertation examined teacher candidates' noticing of mathematics instructional features—the teacher, student, and content—within video of their own teaching. Teacher candidates participating in this study enrolled in a Northwest University master's degree and teacher certification program. The study examined participants' reflections from four common lessons taught and video recorded across two terms of mathematics methods courses. Their reflections were structured by sets of questions that guided teacher candidates in noticing the mathematics instructional features. Data were examined to link teacher candidates' reflections on pedagogical decision-making and their capacity to offer alternative teaching strategies within their reflections based on evidence (Santagata, Zannoni, & Stigler, 2007). This study was driven by the research questions specified in the next section.

Research Questions

The questions driving this study were:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
2. What was the pattern of teacher candidates' noticing within and across the four written reflections?

3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?

Significance of the Study

My study generated information about teacher candidates' noticing when they were provided opportunities to analyze their own teaching. Because teacher candidates' reflections were structured by sets of questions guiding them to reflect on their teaching, their answers to these questions provided significant information about what they noticed. Teacher candidates were asked to pay attention to instructional features—the teacher, student, and mathematical content—as they analyzed their teaching. The study results document the instructional features that teacher candidates noticed.

According to Santagata and Angelici (2010), prompts structuring teacher candidates' reflections play a major role in guiding teacher candidates' noticing. The prompts used in my study were developed based on prior studies on mathematics teaching, mathematics teacher education, and mathematics teacher noticing. These prompts were specifically used with the teacher candidates in the context of my study. Thus, the findings of my study provide information about how these prompts guide teacher candidates' noticing. The implications of this study offer insight on designing teacher education programs.

The context of the study will further be elaborated, along with the methodology employed for the study, in Chapter Three. Prior to discussion of the methodology, Chapter Two provides a review of related literature to situate the study and a conceptual framework, including research questions for the study.

Chapter 2
Literature Reviews and Conceptual Framework

The purpose of this dissertation study was to examine teacher candidates' noticing of interactions among instructional features: the teacher, student, and content. This chapter reviews relevant literature for situating the study. It also provides a conceptual framework and research questions for framing the research. The first section of the chapter details mathematics classroom instruction and instructional features. The second section discusses the entailments of ambitious teaching in the context of mathematics education reform. The third section reviews the literature on teacher noticing and elaborates on the research questions addressed by the study. A conceptual framework and research questions are presented in the last two sections.

Mathematics Classroom Instruction

Learning to notice classroom instruction within this study was conceptualized as a process of learning to examine the complexity of the instructional system. Cohen and colleagues suggested that classroom instruction does not refer to one-way communication from teachers to students (Cohen, Raudenbush, & Ball, 2003). Instead, it refers to the interactional relationships among the teacher, student, and content in particular environments (Cohen, Raudenbush, & Ball, 2003; Lampert, 2001). Some researchers, such as those in the Learning Mathematics for Teaching Project, used the word *instruction*, rather than the word *teaching*, to refer to these dynamic interactions. They reason that the definition of teaching, which focuses on what teachers do in classrooms, is too narrow to explain the entailments of mathematics classrooms that include teacher, student, and content affordances (Learning Mathematics for Teaching Project, 2011).

The interactions among these instructional features are represented in the form of an *instructional triangle* (see Figure 2.1).

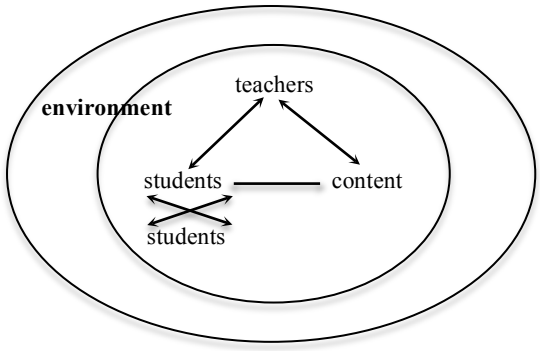

Figure 2.1. Instructional triangle (adapted from Cohen, Raudenbush, & Ball, 2003).

The instructional triangle represents the connections among the teacher, student, and content within the classroom and situates the classroom within departments, schools, and communities (Cohen, Raudenbush, & Ball, 2003). The inner circle suggests a dynamic relationship among students interacting with content with the facilitation of the teacher. Situating the classroom within the environment recognizes that larger affordances and constraints are placed on the classroom. For instance, the teacher and students work within the constraints of particular content, curricular resources, and normative expectations for teaching and learning.

Due to the dynamic connections within classroom instruction shown in the instructional triangle, improving students' mathematical learning by only improving the teacher might not be effective. Instead, teachers' interactions with students and content are important for enhancing students' learning (Cohen, Raudenbush, & Ball, 2003; Hiebert & Morris, 2012). Teachers with the ability to adjust how they interact with content and students, by listening to students' ideas, selecting proper mathematical tasks, and asking appropriate questions, tend to be able to support learners across demographic groups, which is the aim of *ambitious teaching* (Lampert & Graziani, 2009).

Ambitious Teaching

My study of teacher candidates' noticing of mathematics instruction was situated within current mathematics education reform that suggested teachers' need to develop instructional skills to support all students' becoming mathematically proficient. This attention to teachers' instructional skills is based on the idea that mathematically proficient students are required to coordinate mathematical concepts to efficiently, accurately, and flexibly use mathematical procedures as they solve mathematical problems and justify their mathematical work (NCTM,

2000). Further, students are asked to develop habits of mathematical practice that rely on the logical structures of mathematics to both construct mathematical arguments and reflect on their rigor (NRC, 2001). As a result, teachers are asked to teach mathematics in ways that develop and build on students' mathematical reasoning and that ask students to engage in authentic mathematical tasks (Lampert, Boerst, & Graziani, 2011). Often these ambitious goals for student learning differ significantly from how teachers learned mathematics. Further, the instructional practices required to meet these ambitious learning goals are not those typically used. Teachers need to be able to carefully listen to and build upon students' ideas, to facilitate classroom discussion, and to foster each student's learning across ethnic, linguistic, and socioeconomic backgrounds (Kazemi, Franke, & Lampert, 2009; Lampert, Boerst, & Graziani, 2011; NCTM, 2000). Lampert and colleagues advance the idea that for teachers to support students' developing mathematical proficiency, they need to learn to teach ambitiously (Lampert & Graziani, 2009).

Ambitious teaching aims to support all kinds of students not only to understand academic content, but also to use knowledge to solve real-world problems (Lampert & Graziani, 2009). In other words, students in ambitious classrooms have to use knowledge and skills to perform authentic problem solving. As a result, ambitious teachers simultaneously have to teach mathematical knowledge and skills and teach students to perform on authentic problems (Lampert, Boerst, & Graziani, 2011). Teachers need to build on methods that students use to solve mathematical problems and to make sense of students' reasoning about those methods. Teachers use students' reasoning to inform and adjust teaching (Hill, Rowan, & Ball, 2005).

Teacher candidates are required to adapt teaching based on classroom situations in ambitious teaching. However, this kind of teaching is different from the teaching that teacher candidates have experienced as students. In their apprenticeship of observation as students, teacher candidates often view teaching as a process of one-way communication from a teacher to the students (Lampert, 2001; Lortie, 1975). As a result, teacher candidates need support from teacher education programs to prepare them with the knowledge and skills necessary to teach ambitiously (Lampert, 2001). A number of researchers suggest tools in teacher education programs to prepare teacher candidates for ambitious teaching.

Teacher education program supporting ambitious teaching. Grossman, Hammerness, and McDonald (2009) suggested that, to help teacher candidates to learn to teach ambitiously, teacher education programs should provide teacher candidates with both conceptual and practical tools. Further, teacher candidates should have opportunities to gain clinical experiences in

teaching, which would allow them to apply the conceptual and practical tools learned in coursework to authentic classroom teaching. These activities should be organized around a set of practices necessary for ambitious teaching, called *high leverage teaching practices* or *core instructional practices* (Grossman, Hammerness, & McDonald, 2009; Lampert, 2010; Lampert, Franke, Kazemi, Ghousseini, Turrou, Beasley, Cunard, & Crowe, 2013). High leverage practices are a set of practices central to teaching with the purpose of supporting students' learning. Teacher education programs should provide teacher candidates with opportunities to practice this set of teaching skills in order to prepare them to teach effectively.

McDonald, Kazemi, and Kavanagh (2013) suggested a learning cycle in teacher preparation programs that are organized around high leverage practices and are intended to support teacher candidates in learning to teach ambitiously. This learning cycle consists of cycles of investigation and enactment that are divided into four quarters as shown in Figure 2.2.

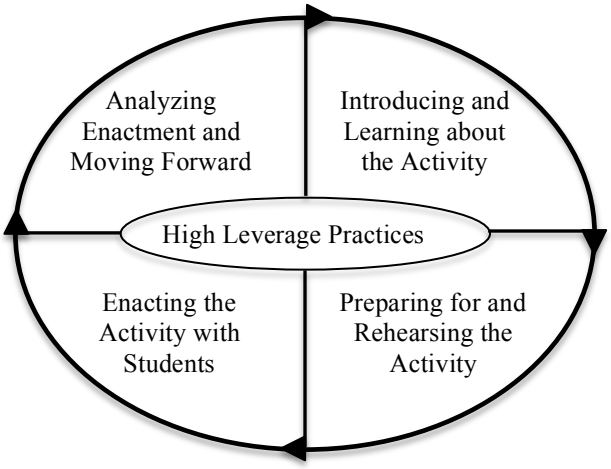

Figure 2.2. Cycles of investigation and enactment as a learning cycle in teacher preparation program (adapted from McDonald, Kazemi, & Kavanagh, 2013).

Figure 2.2 represents the learning cycle of teacher candidates in teacher preparation programs that focuses on the learning of high leverage teaching practices in the work of teaching. Based on this model, a teacher education program helps teacher candidates to learn high leverage practices (HLPs) by starting with the activities that introduce teacher candidates to particular HLPs. Teacher candidates are provided with opportunities to observe various representations of teaching, such as classroom video or real-time enactments. After observing representations of teaching, teacher candidates work with peers and teacher educators to plan an enactment.

Candidates rehearse the HLPs with peers and receive support from teacher educators. Then, they enact HLPs with real students. Finally, they analyze and reflect on their enactments by using tools such as videos.

To learn HLPs based on this learning cycle, teacher candidates use *instructional activities (IAs)*, which are well-designed lessons that specify interactions between teacher and students around mathematical content (Kazemi, Lampert, & Franke, 2009). The use of IAs in student rehearsal is intended to support teacher candidates in developing applicable skills and the knowledge necessary for ambitious teaching, such as posing mathematical problems and responding to students' ideas. Teacher candidates enact particular HLPs by working in the *approximation of practice*, which is work in settings with less or more proximity to the complex and authentic work of classroom teaching (Grossman et al., 2009). For instance, teacher candidates might enact an IA with small groups of students, which is less complicated than working in whole-classroom teaching. After the enactment of the IA, teacher candidates engage in the last process of the learning cycle: analyzing the enactment and moving forward. In this process, teacher candidates reflect on their teaching artifacts of teaching such as video or student work. Candidates' reflections allow them to analyze their teaching and consider alternative instructional decisions.

McDonald and colleges' recommendations for teacher education were applied to the teacher preparation program in my study. Cycles of investigation and enactment were used to support teacher candidates building skill with HLPs necessary for ambitious teaching. The applications of these ideas within the teacher preparation program in my study are provided in the next section.

Teacher education program in the context of the study. The context of my study was a masters-level teacher education program in secondary mathematics. The program was inspired by the work of the Learning in, from, and for Teaching Practice (LTP). This program was operated under sets of *principles of high quality teaching* and *principles of learning to teach* (see Appendix A).

The 11-month teacher education program, began in August and ran through the following June. In summer term, teacher candidates learned about ambitious instruction and observed in-service teachers' teaching via video records. In fall and winter terms, teacher candidates enrolled in part-time student teaching and participated in two mathematics methods courses. They enrolled in full-time student teaching in the spring term. During their enrollment in mathematics

methods courses, teacher candidates developed the skills needed to teach ambitiously by participating in four cycles of investigation and enactment using secondary math IAs organized around HLPs (see Table 2.1).

Table 2.1

High Leverage Practices of Ambitious Teaching (Elliott & Aaron, 2014; adapted from Kazemi, Franke, & Lampert, 2009; Lampert et al., 2013; LTP project)

High Leverage Practices of Ambitious Teaching
1. Teaching toward a clear learning goal
2. Representing student reasoning verbally and visually
3. Constructing and organizing public records
4. Eliciting and responding to student contributions
5. Orienting students to one another and to the discipline
6. Making sense of students' participation to inform instruction
7. Positioning students as competent
8. Developing and maintaining a productive learning environment
9. Managing time and pacing
10. Using body and voice

IAs designed to emphasize particular practices and mathematical content were used as tools for developing skills to teach ambitiously. Teacher educators selected a subset of HLPs as a focus of teaching practice. Then, the teacher educators developed IAs emphasizing the particular practices in specific mathematical content aligned with a collaborating secondary mathematics teacher. These IAs were used to support teacher candidates developing instructional knowledge and skill through enactments in mathematics methods courses and secondary classrooms. The use of IAs in the enactments was based on the cycles of investigation and enactment.

In the mathematics methods courses, teacher candidates were introduced to the IAs through observing and discussing the IAs. They were provided with opportunities to observe the teacher educator's demonstration of teaching by using the IAs. Also, they discussed their observation. These processes were part of the process of *introducing and learning about the activities*, which was the first process of the learning cycle. Teacher candidates worked with peers and teacher educators to plan for the rehearsal of the IAs. Then, they rehearsed the IAs

with peers with support from teacher educators and teaching coaches. These processes were situated in the second process of the learning cycle, *preparing for and rehearsing the activities.* Then, teacher candidates participated in the third process of the learning cycle, *enacting the activities with students.* They were provided with opportunities to enact activities with small groups of secondary math students, in what was called *student rehearsals*. All student rehearsals were videotaped. The videos of their student rehearsals were used in the last process of the learning cycle, *analyzing enactment and moving forward.* After each student rehearsal, teacher candidates reviewed their own video and reflected on and wrote about their teaching using a structured set of questions. In their reflections, teacher candidates were asked to identify the significant moments of their classroom instruction and to explain how they understood those particular moments. These reflection topics were directly related to the idea of *teacher noticing.*

Mathematics Teacher Noticing

In my dissertation study, teacher candidates were situated in a context of mathematics education reform that required them to be adaptive and responsive in classroom teaching. They needed to learn to see, understand, and attend to classroom situations that supported students' learning mathematics with understanding, as well as being able to solve authentic tasks. I argue that candidates' noticing abilities were key to developing ambitious teaching.

The idea of noticing originates from what Goodwin (1994) calls *professional vision*, which is the specific way in which people in a profession see and understand phenomena. The ability to see and make sense of meaningful events distinguishes a profession. For instance, a farmer might see a plot of land and consider how the soil could support the growth of crops; an archeologist might look at the same landscape and see artifacts that provide evidence for earlier human activities (Goodwin, 1994). When individuals become members of a professional group, they are practiced at seeing situations in a particular way.

Teachers, as professionals, have a specific type of professional vision, called *teacher professional vision.* Sherin (2001) defines teacher professional vision as the ability to see and understand interactions in classrooms. Among the dynamic classroom relations, teachers have to be able to see and make sense of how the lesson is unfolding. Also, teachers have to see specific situations involving students and integrate the knowledge necessary for teaching with what they see in order to understand those situations and make appropriate pedagogical decisions. For instance, when a student answers a mathematical problem incorrectly, other professions might

only see the incorrectness. In contrast, with the knowledge necessary for mathematics teaching, a teacher might be able to diagnose students' mathematical conceptions and misconceptions from a student's answer.

These skills are not what teachers do automatically. Sometimes teachers are not able to see the significant ideas of students. This situation is called *inattentional blindness* (Simon & Chabris, 1999). According to Simon and Chabris, this is when a student raises important evidence that is observable, however a teacher's focus is not on this evidence. Thus, teachers need to practice sensitizing to classroom events that might be opportunities in future teaching. The ability to sensitize important classroom situations is what Mason (2011) calls *teacher professional noticing*. Teachers need professional noticing in order to shift attention from their habitual actions to significant classroom situations. Then, teachers need to appropriately respond to significant classroom situations in order to promote students' learning. Mason concludes that, for effective teaching, teachers should be able to notice the moments that important situations occur and respond freshly rather than habitually.

Teachers' noticing of significant classroom situations and responding to those situations is based on some processes. Sherin and van Es (2005) identify three aspects of teacher noticing in their *Learning to Notice Framework*: (1) *highlighting* noteworthy situations, (2) *reasoning* about the situations, and (3) *connecting* the situations with teaching and learning principles. Teachers need to identify important moments in classroom teaching and make sense of the selected moments based on their knowledge and experiences. However, as aforementioned, teachers should be able to appropriately and freshly respond to the situations. Thus, *proposing pedagogical alternatives* might be included as the last process of teacher noticing.

Mason's conception of teacher noticing includes proposing pedagogical alternatives. Mason's (2011) conceptualization of teacher noticing suggests that teacher noticing involves three processes: (1) *marking* significant classroom situations, (2) *interpreting* those significant situations, and (3) *proposing teaching alternatives* that might be effective in enhancing students' learning. These processes are relevant to Jacobs, Lamb, and Philipp's (2010) characterization of teacher noticing, which includes *attending* to specific moments, *interpreting* those attended moments, and *deciding* on teaching (see a summary of the aforementioned teacher noticing aspects in Table 2.2). Sherin and van Es' work and Jacob and colleagues' work were used to study teacher noticing of student thinking. However, my dissertation not only focused on the noticing of student thinking rather it focused on the noticing of relationships among the teacher,

student, and content. Thus, Mason's conception of teacher noticing, which is broader than the conceptions by Sherin and van Es and by Jacobs and colleagues was used in my study.

Table 2.2

A Summary of Teacher Professional Noticing Aspects

Sherin & van Es (2005)	Mason (2011)	Jacobs, Lamb, & Philipp (2010)
• Highlighting noteworthy situations	• Marking significant classroom situations	• Attending to specific moments
• Reasoning about the situations • Connecting the situations with teaching and learning principles	• Interpreting the marked situations	• Interpreting the attended moments
	• Proposing teaching alternatives	• Deciding on teaching

Conceptual Framework

Mason's conception of teacher noticing was used in several studies attending to different noticing foci. For instance, Santagata, Zannoni, and Stigler (2007) focus on teacher candidates' noticing of students' mathematical thinking. Teacher candidates in their study reviewed classroom video and constructed written reflections noting significant moments of students' thinking within a lesson. After teacher candidates engaged in repeated opportunities to reflect, they had a greater ability to notice significant moments of students' thinking.

A focus on students' thinking by teacher candidates in Santagata and colleagues' study is only one aspect of the instructional triangle; teacher candidates need to learn to notice broader classroom features. A study by Star and Strickland (2008) provided teacher candidates with opportunities to learn to notice various features of instruction by reflecting on teaching in classroom videos. In their study, teacher candidates completed pre- and post-assessments designed to investigate what teacher candidates noticed after watching classroom videos. These assessments consisted of questions asking teacher candidates to recall significant classroom situations on five observation topics: classroom environment, classroom management, tasks, mathematical content, and communication. Following a pre-assessment, teacher candidates participated in learning to notice by watching classroom videos, taking notes on situations in the videos, and discussing classroom situations surrounding each observation topic. The researchers claimed that teacher

candidates learned to notice by participating in this intervention over one semester. Candidates completed a post-assessment at the end of the semester. Results of the study revealed that teacher candidates improved their abilities to mark classroom moments related to these five topics.

The results of Star and Strickland's study were relevant for my dissertation, which required teacher candidates to notice various instructional features from video. Star and Strickland's results showed that teacher candidates were able to learn to notice various features of instruction from watching classroom videos and engaging in reflection on teaching. Thus, my dissertation was based on the assumption that, after learning to notice by watching classroom videos and reflecting on teaching, teacher candidates participating in my study will be able to learn to notice features of the instructional triangle: the teacher, student, and content.

Within my study, I argue that the features of instruction are in a dynamic relationship within classroom instruction. Star and Strickland's (2008) study was one of the noticing studies that paid attention to interactions within classroom instruction. As aforementioned, they included communication as a topic that teacher candidates learned to notice. However, this topic concerned only the interaction between the teacher and students. It did not involve how the teacher and students interacted with mathematical content. Even though the topic of mathematical content was included as one of the observation topics in this study, it referred to mathematical representations, examples, and problems used in classroom teaching. This study did not involve how mathematical content worked in communication between the teacher and students. In other words, this study did not pay attention to interactions among all features of an instructional system. My dissertation study included attention to the interactions of the teacher and students with mathematical content therefore advancing a unique conception of teacher noticing. Teacher candidates in my study were required to learn to notice both instructional features and interactions among these features.

Due to Mason's conception of teacher noticing, learning to mark significant moments involving instructional features and their interactions was not sufficient. Also, teacher candidates in my study had to learn to interpret those moments. The results of several studies revealed that teachers and teacher candidates usually had problems with interpreting classroom situations. For instance, a study by Sherin and van Es (2005) focused on teacher noticing from the video of classroom teaching and facilitated discussions. Teachers participating in this study watched and discussed significant moments of classroom teaching in video clubs facilitated by a researcher using open-ended questions. In the early video clubs, teachers usually described and evaluated

marked moments rather than interpreting those moments. However, a shift took place in how they discussed what they noticed to be more interpretative. Teachers focused on making sense of classroom situations rather than describing or making judgments about those situations. In other words, teachers who learned to notice from watching videos of classroom teaching and engaging in reflection on classroom teaching with facilitation were able to shift how they discussed the moments they noticed.

In addition to teachers participating in a study by van Es and Sherin (2008), teachers participating in this study learned to notice by watching videos of classroom teaching and engaging in reflection on teaching in video clubs facilitated by a researcher. The results of this study revealed that the percentage of interpretative comments increased, while the percentages of descriptive and evaluative comments decreased. Teachers were able to shift how they commented about classroom teaching if they were supported in learning to notice through watching videos of classroom teaching and receiving guidance in their reflections. However, these studies of the interpretation of classroom situations were conducted in groups of in-service teachers. A study that examined teacher candidates' interpretation of classroom events was still needed. Thus, my dissertation study included the exploration of how teacher candidates interpreted classroom situations when they were provided with opportunities to learn to notice by watching classroom videos and reflecting on teaching in those videos.

However, van Es (2011) explained that, besides the interpretation of classroom situations, teachers had to be able to make productive comments on classroom teaching by elaborating on specific evidence from videos to their comments. In her study, teachers were encouraged to interpret and use specific evidence from videos to support their interpretation claims. Teachers in this study were guided to elaborate on specific evidence to support their interpretation claims by specific questions, such as "Where do you see that?" As a result, teachers participating in this study were able to use specific evidence from classroom videos to support their claims. Even though van Es' study was conducted with a group of in-service teachers, my dissertation study was directed by this study in the sense that the use of specific evidence from video to support interpretation claims could be guided by questions that specifically asked research participants to focus on the situations in the videos. Thus, my dissertation study, which was conducted with a group of teacher candidates, included exploration of how teacher candidates used specific evidence in videos to support their interpretations when specific guidance was provided.

Various kinds of guidance were offered to teachers and teacher candidates as they learned to notice by engaging in reflection. These kinds of guidance could be identified into two groups: unstructured and structured reflections. For instance, teachers in van Es and Sherin's (2008) study were guided to reflect on teaching in video clubs by a facilitator. Questions used to guide teachers were flexible and adjustable based on discussion in the video clubs. Thus, the reflections in the video clubs were unstructured. In contrast, teacher candidates in a study by Santagata and Angelici (2010) engaged in structured reflections. They responded to three specific prompts after watching classroom videos. When teacher candidates engaged in structured reflections, such as answering a set of questions, they were able to work individually. Thus, in the context of my dissertation study, teacher candidates engaged in structured reflections in order to learn to notice.

In Santagata and Angelici's (2010) study, teacher candidates learned to notice by watching classroom videos from the International Mathematics and Science Study (TIMSS). Then, candidates were divided into two groups. Teacher candidates in each group learned to notice by using different methods. Those in the experimental group learned to notice by answering a set of questions that were specific to the noticing topic of the study. The results of this study showed that teacher candidates in the experimental group had better performance in noticing the topic on which the study focused. Based on the results from Santagata and Angelici's study, because my dissertation study focused on instructional features and the interactions among those features, a set of questions used to guide written reflections in my study was specific to the instructional features and their interactions. However, the use of TIMSS classroom videos in Italy, as in Santagata and Angelici's study, might not be appropriate to teacher candidates in my study because classroom teaching in the videos might be different from classroom teaching in the United States. Therefore, my dissertation study preferred to use videos of teacher candidates' classroom teaching. Teacher candidates in my dissertation study were supported in learning to notice by writing structured reflections about their own teaching.

In summary, prior studies on teacher noticing highlighted the instructional features that teachers and teacher candidates learned to notice. Learning to notice just the instructional features was insufficient. Teachers and teacher candidates needed to learn to notice interactions among the teacher, students, and content in order to teach ambitiously. Noticing in this notion included not only marking the significant interactions in classroom instruction but also interpreting those interactions by using specific evidence to support the interpretation claims and proposing teaching alternatives that might be effective in students' learning.

Research Questions

The research questions informing the study were the following:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
    - 1.1 What topic did teacher candidates most frequently notice?
    - 1.2 Did teacher candidates include specific evidence from classroom teaching to support their claims about the moments they noticed?
    - 1.3 What instructional feature did teacher candidates most frequently notice?
    - 1.4 What stance did teacher candidates most frequently take as they talked about classroom teaching?
2. What was the pattern of teacher candidates' noticing within and across the four written reflections?
    - 2.1 What was the pattern of the topic that teacher candidates noticed?
    - 2.2 What was the pattern for how teacher candidates included specific evidence from classroom teaching to support their claims about teaching?
    - 2.3 What was the pattern of the instructional feature on which teacher candidates focused?
    - 2.4 What was the pattern of the stance that teacher candidates took?
3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?
    - 3.1 How were the stances that teacher candidates took related to the topics that teacher candidates noticed?
    - 3.2 How were the stances that teacher candidates took related to how teacher candidates included their teaching evidence?
    - 3.3 How were the stances that teacher candidates took related to the instructional features on which teacher candidates focused?

Answers to these research questions were explored through my descriptive study of teacher candidates' learning to notice. This study sought to understand what and how teacher candidates noticed significant moments in classroom teaching. The research methodology for my study is provided in Chapter Three.

Chapter 3
Methodology

The intent of this study was to describe what teacher candidates noticed and understood when given opportunities to engage in learning to notice from watching classroom videos. From teacher candidates' written reflections of their classroom teaching, I examined: (1) the topics and instructional features on which teacher candidates focused, (2) the use of evidence to support their claims about the significant moments, (3) how teacher candidates analyzed these moments, and (4) propositions of teaching alternatives that teacher candidates might make. This exploration was designated to answer the following research questions:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
2. What was the pattern of teacher candidates' noticing within and across the four written reflections?
3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?

This chapter presents the research methodology used to answer these research questions. The first section of the chapter describes the research setting and participants. The second section describes data. The last section presents the data analysis process.

Research Setting and Participants

Data for my study were collected during the 2014–2015 academic year with 11 teacher candidates who enrolled in a master's degree and teacher certification program. In this study, I used the pseudonyms TC01, TC02, … , TC10, TC11 to refer to the first, the second, … , the 10th, the 11th (last) teacher candidates, respectively. This 11-month program, which enrolled students with undergraduate degrees in mathematics or related fields, offered two content-specific methods courses and two student-teaching placements.

In the two mathematics methods courses, teacher candidates engaged in cycles of investigation and enactment where they rehearsed designed lessons, or IAs, that specified high leverage teaching practices and instructional routines supporting secondary mathematics students learning the ambitious goals of the Common Core State Standards in Mathematics (Common Core State Standards Initiative, 2010). The use of IAs in the master's degree program aimed to

support teacher candidates in developing skills with *high leverage teaching practices* (Elliott & Aaron, 2014; see Chapter 2). The data corpus for the study was drawn from the analysis of teacher candidates' reflecting on their own teaching during four cycles of enactment across the two mathematics methods courses (see Table 3.1).

Table 3.1

Context and Mathematical Content for Four Cycles of Enactment

Term	Course	Mathematical content	Level
Fall 2014	Algebra II /Algebra II Honors	Linear Programming tasks	High school
	Pre-algebra	Multiple representations of functions	Middle school
Winter 2015	Pre-algebra	Error analysis of slope intercepts	Middle school
	Geometry	Trigonometric Ratios	High school

During each cycle, teacher candidates engaged in student rehearsals and constructed reflections based on the rehearsal. Rehearsals were video recorded to aid in reflection. Teacher candidates' written reflections, guided by sets of questions to support noticing significant moments in classroom teaching connected to high leverage practices and program aims, were assigned at the end of each cycle of enactment (Appendix B). The questions prompted teacher candidates to mark and interpret interactions within classroom instruction that they saw in their videos of student rehearsals. In each written reflection, teacher candidates selected and transcribed video clips that showed their work on selected high leverage practices: (1) using discourse moves, (2) orienting students to one another and/or the discipline, (3) eliciting and responding to student thinking, and (4) teaching toward a clear learning goal. Teacher candidates had to explain the reasons for their selection of particular clips. Also, they were asked to explain how they made sense of situations in the selected clips with explanations based on specific evidence in the selected clips.

Data Collection

To address my research questions proposed in Chapter Two:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
2. What was the pattern of teacher candidates' noticing within and across the four written reflections?
3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?

Teacher candidates' written reflections on their teaching were data sources for my study. Eleven teacher candidates participated in four student rehearsals comprising 44 written reflections. These data allowed me to explore what teacher candidates noticed in their own teaching.

As aforementioned in the previous section, the written reflections were structured by sets of questions asking teacher candidates to mark and interpret significant interactions within classroom instruction from their videos of student rehearsals. These sets of questions were mainly divided into three parts: part A, part B, and part C. The questions in part A asked teacher candidates to select two to three short video clips from their student rehearsals that showed their work on high leverage practices in using discourse moves, orienting students and/or the discipline, eliciting and responding to students, and teaching toward a clear learning goal. For each clip, teacher candidates had to transcribe the selected video clips and describe the situations in the video clips. Then, they had to explain how they understood students' participation and interplay between their contributions and students' contributions within a mathematical context. For part B, teacher candidates were asked to explain their growth in teaching practices by comparing their teaching in student teaching, peer rehearsals, and student rehearsals. For part C, teacher candidates had to explain their teaching difficulties and their teaching goals. More details about the questions guiding teacher candidates' written reflections were provided in Appendix B.

In summary, the sets of questions in my study guided teacher candidates in thinking about their instruction in terms of the interactions among the teacher, student, and mathematical content. The written responses to these sets of questions would be a data source for exploring teacher candidates' attention. The analyses of the written responses to these sets of questions would explain the topics on which teacher candidates focused, the inclusion of teaching evidence, the instructional features that teacher candidates paid attention, and the actions that teacher

candidates took as they analyzed their teaching. More details about the analyses of teacher candidates' reflections are included in the next section.

Data Analyses

In this section, I describe the data analysis processes by dividing this section into three sub-sections. First, I explain the coding scheme I used to code my data. I include the definition and example of each coding dimension and category in this sub-section. Second, I describe how I refined and validated the coding scheme before applying the coding scheme to code the data. Last, I explain how I coded the data and the statistical analyses used to analyze the coded data.

Coding scheme. My coding scheme was developed based on prior studies on mathematics teacher noticing by Sherin and van Es (2009) and Santagata and Angelici (2010). The coding scheme consists of four coding dimensions. A summary of the coding scheme, including coding dimensions and categories, is given in Table 3.2.

Table 3.2

A Summary of Coding Dimensions and Categories

Dimension	Category
Topic	• Teacher's instruction (TI) • Students' participation (SP) • Mathematical content (MC)
Presence of evidence	• No evidence (N) • Presented evidence (Y)
Instructional feature	• Teacher (T) • Students (S) • Content (C) • Teacher and student (TS) • Teacher and content (TC) • Students and content (SC) • Teacher, students, and content (TSC)
Stance	• Evaluate (E) • Describe (D) • Interpret (I) • Offer teaching alternative (A) • Offer personal perspective (P)

The first coding dimension is *topic*. Van Es and Sherin (2008) defined this dimension as what teachers noticed. In their study, this dimension included categories of mathematical thinking, pedagogy, classroom climate, and classroom management. However, these categories were not the topics that teacher candidates in my study learned to notice. The teacher candidates in my study were promoted to learn to notice the features of an instructional system. They were guided to reflect on teaching based on the sets of questions focusing on these instructional features. Thus, the topic dimension of my study included three categories from the features of an instructional system: (1) *teacher's instruction*, (2) *students' participation*, and (3) *mathematical content*.

An example of the code teacher's instruction is generally about an instance when the teacher candidates highlighted high leverage practices or other instructional moves. The following example shows TC02's talking about the practice of eliciting students' reasoning and asking clarifying questions to support the group understanding a solution.

> I chose this clip because it showed me eliciting students' contributions as well and responding to it. …. I responded to Student TH's input by asking a clarifying question in order to ensure students knew which step of the solution Student TH was considering. … (TC023A05)

The written reflections coded as students' participation generally talked about situations in which students participated in classroom instruction, such as asking questions, answering mathematical problems, or proposing mathematical ideas. The following example shows TC01's talking about what three students did in a classroom discussion.

> Three students participated verbally in this discussion. One student told the class what they wrote for number one. The next student shared a response similar to the first, and the third student repeated and rephrased what the second student shared with the class. … (TC012A07)

An example of the last topic code, mathematical content, is generally about specific mathematical content taught in the lesson or the use of mathematical content to solve a mathematical problem. The following example shows teacher TC09's talking about students' mathematical understanding of negative fractions.

> … However, after thinking about it more, I feel as though he was looking at the negative 1 as an inseparable part of the negative 5 and negative 2, as opposed to negative 5 being the product of 5 and -1. … (TC093A07)

The second coding dimension is *presence of evidence*. This dimension concerns if teacher candidates included specific evidence from classroom instruction to support claims in their reflections. The presence of evidence, an aspect of productive comments on classroom teaching, was important to teacher candidates' learning to notice. As teacher candidates used evidence to support claims, they showed abilities to connect specific events that they saw from the classroom videos to the principles of teaching and learning (Sherin & van Es, 2005). However, teacher candidates might have not included specific evidence of classroom teaching in their reflections. The narrative that did not include specific instructional evidence was coded as *no evidence*. The following example shows TC04's explaining her improvement in using discourse moves. Even though she talked about what she had learned in order to improve her ability, she did not include evidence tying her improvement to what she had learned.

> My improvement in using discourse moves, … I've learned to use discourse moves to orient students to each other by asking them to rephrase what their peers say or to add any information they felt like their peers might have left off. … (TC041B11A)

In contrast, TC10 talked about her improvement in teaching by including specific evidence in her classroom instruction. She gave examples showing the differences in her responses to students in two classes. The following narrative is an example of the idea unit coded as *presented evidence.*

> … I also see growth in my ability to answer questions more confidently. In my lesson at [school], I was constantly responding to students with "OK…" giving myself a 3 second think-time before I responded. In this video I feel more confident in my ability to teach, and was able to respond. For example, when I asked how the two answers differed in the response to the graph, I didn't even remember doing that. … (TC102B07A)

In summary, the *presence of evidence* dimension consists of two coding categories: (1) *no evidence* and (2) *presented evidence.*

The third coding dimension, *instructional feature*, concerns the existence of instructional features—the teacher, student, and content—in teacher candidates' reflections. This dimension focuses not only on if teacher candidates included instructional features in their claims but also on what features were included. When teacher candidates reflected on their teaching, they might

have focused on only one feature of instruction. In the following, TC07 talked about her using a watch to time her instructional activity. This quote is coded as *teacher* because, besides the teacher, this quote does not include the other two features of instruction.

> … In my second video clip, I use my watch to time the partner talk. I do this for two reasons, the first of which is to make sure that I don't spend too much unnecessary time on any one activity. … (TC071B07A)

In addition to the previous example, TC01 focused on only one instructional feature in her reflection of classroom teaching. Her reflection is quoted as *student* because it focused on only a student.

> … She didn't want to be called on and I don't think she wanted to be wrong in front of her peers. Mathematically students weren't really participating. … (TC011A05)

The next example is a narrative that focused only on mathematical content. In this example, TC01 was talking about the Pythagorean theorem and the trigonometry that her students might use to solve mathematical problems.

> … What I wanted to be clear about was the distinction between side lengths of a right triangle and angles in a right triangle. Although we can use both the pythagorean theorem and trigonometry to solve for side lengths, the two ideas are different. (TC014A03)

Based on Cohen and colleagues' (2003) instructional triangle, the instructional features were interconnected. Teacher candidates might focus on interactions between two instructional features: the teacher and student, teacher and content, and student and content. The following quote shows a teacher candidate's reflection that focused on the interaction between the teacher and student. This quote is an example of the idea unit coded as *teacher-student.* This example shows how TC06 talked about her response to the student's answer.

> … When [Student] put the second sentence in his own words, I asked if someone could rephrase what he said. … (TC061A01)

Teacher candidates might focus on the interaction between the teacher and mathematics in their written reflections. The following example shows how TC01 explained operating cost in her pre-algebra class. This quote is coded as *teacher-content.*

> The last statement of this particular clip was made by me, and I stated, "Now, we can clearly see that our operating cost is 1000 dollars, so if we sell zero tickets we are in the hole 1000 dollars.". … (TC012A05)

Also, a written reflection might show the focus on the interaction between the student and mathematical content. The following example shows TC02's talking about the student's explanation to find the break-even point. This quote is coded as *student-content.*

> … [Student] supported his partner's reasoning by saying that since it said 0 dollars on the table that there needed to be 200 tickets to break even. … (TC022A08)

Importantly, teacher candidates might emphasize interactions among all three instructional features. An example of the code *teacher-student-content* is generally about an instance when teacher candidates highlighted specific classroom situations that consisted of the teacher and students' talk about mathematical content or about solving a mathematical problem. The following example shows TC04's talking about how her student solved a problem about operating cost and how she responded to the student's idea.

> [Student] tells me that she used the situation and the table to find the operating cost. She was able to easily explain where she found it in the situation, but once I asked her about the table, she told me that it was at the point (400, 1000). … (TC042A05)

In summary, teacher candidates might include one, two, or three instructional features in their claims about classroom instruction. Thus, the dimension of instructional feature consists of seven categories in three groups. The first group of categories shows the existence of one instructional feature in the idea unit: the teacher, student, and content. The second group of categories shows the existence of a connection between two instructional features in the idea unit: the teacher and student, teacher and content, and student and content. The last category shows the existence of a connection among all three instructional features in the idea unit, which are the teacher, student, and content.

The last dimension highlighted in teacher candidates' written reflections is *stance*. This dimension refers to how teacher candidates analyze practice. According to van Es and Sherin (2002, 2008), when teachers engage in reflection on practice, they might take different stances, such as describe, interpret, evaluate, propose teaching alternatives, and propose a personal

perspective. Thus, the stance dimension in my study consisted of five categories: (1) *evaluate*, (2) *describe*, (3) *interpret*, (4) *offer teaching alternative*, and (5) *offer personal perspective.*

Based on Sherin and van Es (2009), I defined *evaluate* as making judgments about the quality of the interactions among instructional features that teacher candidates see in classroom videos. An example of the *evaluate* code is generally about an instance when teacher candidates included their judgments and feelings about their instruction. The following example shows TC05's making a judgment about her use of discourse moves.

> My reasoning to use this discourse moved was to summarize what Peter had just finished saying to reconnect students and not make it only a "Peter and teacher" conversation. However, I don't think I used the proper discourse moves. … (TC051A09)

The written reflection, which is coded as *evaluate*, included teacher candidates' narratives explaining their teaching difficulties. The following example shows TC10's talking about her difficulty in classroom teaching.

> I think that it's particularly difficult for me to withhold from answering questions. When students raise their hand with a question or a confusion … (TC102C09)

Also, a written reflection with an explanation of teacher candidates' teaching growth is coded as *evaluate*. The following example shows TC08's talking about the teaching growth she saw in her teaching practice.

> Another area I have seen growth is with the teaching practice using body and voice. I feel as if this is a practice I had a lot of trouble with when I first began teaching, and I have been getting better every time I teach. … (TC082B08)

The second category of stance dimension, *describe*, is defined as a description of what was happening in the selected clip. The following example is how TC11 talked about his instruction by explaining what he did to students.

> … I ask [Student A] to use her own words to explain what the first sentence tells her about the problem. I ask [Student B] to use her own words to make sense out of the second sentence. I ask [Student C] what the third sentence means to her. … (TC111A02)

In a written reflection, teacher candidates might have made claims about events. In other words, they were interpreting what was happening in the selected clip. An example of the code *interpret*

might be an instance where teacher candidates were interpreting students' thinking from their answers or proposed ideas. The following example shows TC03's interpreting her student's answer.

> … After the student made the statement, I first assumed that s/he meant to say side instead of angle. … (TC031A04)

Also, an example of the code *interpret* includes an instance where teacher candidates were interpreting themselves. The following example shows TC07's interpreting her activity in enhancing students' learning.

> … I believe that the way in which I set up the activity for the students, allowed them to begin thinking in a general sense about the process of how to find a slope and a y-intercept. … (TC073A01)

Teacher candidates might have proposed teaching alternatives that differed from the teaching in the selected video clip. These idea units are coded as *offering teaching alternative.* The below example shows TC10's proposing a teaching alternative related to the concept of a linear equation in her pre-algebra class.

> … I think that I could have dug deeper, into why this form gives us a magical slope and y-intercept … (TC103A06)

Lastly, teacher candidates might have talked about teaching and learning in general. This talk might not have connected to a particular moment in the classroom teaching. The following example shows TC05's proposing her perspective about using the AB protocol in classroom teaching.

> … Using the AB protocol allowed the students guidance on how to share this information, rather than just showing their partner their paper and assuming they understood what their partner wrote. … (TC051A03)

Teacher candidates might talk about their teaching goals in their reflections. These reflections were also coded as *offering personal perspective*. The following example shows TC09's talking about her goal of improving teaching practices.

> … I want to continue building my arsenal of teaching tools (discourse moves, structured math talk, etc.), and definitely continue to foster growth in my questioning abilities. … (TC094C13)

For the stance dimension, one idea unit could be coded with multiple stances, such as *critique* and *interpret* or *critique* and *offer teaching alternative*. However, the codes *describe* and *interpret* could not be assigned to the same idea units because the *interpret* stance was the stance that moved beyond the *describe* stance.

After I created an initial coding scheme with four coding dimensions with coding categories for each dimension, I refined and validated the coding scheme. The processes for refining and validating the coding scheme are detailed in the next sub-section.

Refining and validating the coding scheme. Validating the coding scheme was conducted in two phases. In the first phase, two researchers coded four randomly selected written reflections—one teacher candidate's reflection for each of the four IAs—to divide the written narratives into *idea units* (Jacobs & Morita, 2002). Identifying an idea unit was a means to chunk the data for coding. The written reflections were divided into segments based on the written topics in the teacher candidates' reflections. Each time the narrative in a written reflection shifted to a new topic, it was divided as another idea unit. Frequently, an idea unit was identified as a paragraph of text (as noted by teacher candidates' formatting). However, teacher candidates might have included more than one topic in one paragraph. Paragraphs with more than one topic were sub-divided into different idea units based on researchers' discussion.

In the first phase of the validation process, two researchers double coded four randomly selected reflections using the initial coding scheme as described above. This phase was conducted to examine the robustness of the coding scheme for the analysis of all of the components of the reflection. Coding four reflections allowed for examining the teacher candidates' full narrative reflections as samples in order to comprehend the codes. We independently coded the other three reflections. Then, we discussed agreements with disagreements rectified. The coding scheme was refined during this process by expanding or collapsing the definitions of the coding dimensions and categories.

After refining the coding scheme, I reviewed all written reflections across the four IAs. During this process, I segmented the narratives into idea units. There were a total of 584 idea units within 44 written reflections from 11 teacher candidates. The number of idea units in the written reflections for each IA is shown in Table 3.3.

Table 3.3

Numbers of Idea Units for Each Reflection

Reflection	Number of Idea Units
1	184
2	149
3	108
4	143

Then, I developed a codebook to identify codes. I reviewed all idea units across the four IAs in order to explore the idea units illustrating the examples and non-examples of codes.

After refining the coding scheme and developing a codebook, I randomly selected 60 idea units (10.3% of all idea units) from all 44 written reflections across the four IAs. All quotes from the selected idea units were entered into a Microsoft Excel spreadsheet. The second researcher and I independently double coded the randomly selected idea units. We entered all of the codes into the spreadsheet so that we could compare the codes assigned by two researchers. This coding resulted in an 87% agreement. The codes in dispute were independently explored by researchers so that they could come to an agreement. Then, we discussed adding more details to the codebook for a reference when coding the entire data set.

Analyses of written reflections. All idea units in the entire data set were entered into an Excel spreadsheet. I coded all idea units in the four coding dimensions identified in the coding scheme. Each idea unit could not be assigned more than one code in the topic, the presence of evidence, and the instructional feature, but it could be assigned more than one code in the stance dimension. I entered codes associated with each idea unit in the Excel spreadsheet.

After I finished coding all of the data, I prepared the data for the statistical analyses. Descriptive statistical analyses and statistical graphics were employed in order to answer my research questions as described in the followings.

Analysis for noticing categories and noticing patterns. To explore the noticing categories and noticing patterns, I began with exploring the noticing categories that teacher candidates most frequently noticed in each noticing dimension. By using Excel, I counted the frequencies and calculated the percentages of the idea units associated with the categories in the dimensions of topic, presence of evidence, instructional feature, and stance, respectively. I reported the percentages of the idea units associated with the categories in these noticing

dimensions. The categories in the dimensions of topic, presence of evidence, instructional feature, and stance, with high percentages of idea units associated with them, were reported as the topic on which teacher candidates most frequently focused; the use of teaching evidence; the instructional feature to which teacher candidates most frequently paid attention; and the stance that teacher candidates most frequently took, respectively.

Based on these results, I prepared the data set for the exploration of noticing patterns. I excluded some outliers from the data set. The categories with low percentages of the idea units associated with them were removed. The idea units coded as the removed categories were assumed as outliers and were excluded from the analyses for patterns of teacher candidates' noticing.

Then, I started to explore the patterns of teacher candidates' noticing. My exploration of noticing patterns consisted of noticing patterns within and across written reflections. I examined the noticing patterns within each reflection based on the percentages of the idea units associated with categories in each noticing dimension. I also employed statistical graphics to explain these patterns with the benefit of visualizing the quantitative information, including revealing patterns in a large data set (Chamber, Cleveland, Kleiner, & Tukey, 1983; Jacoby, 1997). I employed bar charts to visualize patterns of noticing because the bar charts were appropriate for displaying and comparing categorical variables (Schmid, 1983; Sonnad, 2002). In each noticing dimension, I created stacked bar charts to visualize and compare percentages of the idea units associated with different categories within each reflection. These visual representations showed patterns of how teacher candidates noticed different noticing categories in each reflection. In addition, I calculated the measures of center (mean and median), the variance of data from the mean or the standard deviation, the coefficient of variation, which normalizes the variance facilitating comparisons of standard deviation across codes, and the inner-quartile range to explain where 50% of the data lie within any code.

Similarly, I employed statistical graphics to examine the noticing patterns across four reflections. In each noticing dimension, I created stacked bar charts to visualize and compare the percentages of the idea units associated with each category across four reflections. These representations revealed patterns of how teacher candidates noticed a particular category across four reflections. From these bar charts, I could summarize the noticing patterns occupied by overall teacher candidates in four noticing dimensions.

The exploration of noticing patterns across reflections in my study also included the noticing patterns occupied by individual teacher candidates across four reflections. By using Excel, I counted and calculated percentages of the idea units associated with different categories in the dimensions of topic, presence of evidence, instructional feature, and stance, respectively, by individual teacher candidates. Similar to the exploration of noticing patterns across reflections occupied by overall teacher candidates, I employed statistical graphics for examining the noticing patterns occupied by individual teacher candidates. I created stacked bar charts to visualize and compare percentages of the idea units associated with different categories across four reflections by individual teacher candidates. These representations showed patterns of how individual teacher candidates noticed a particular category across four reflections.

Analyses for relationships between stance and other dimensions. To start analyzing the relationship between stance and other dimensions, I counted the frequencies and calculated the percentages of the idea units associated with each stance and each category in each noticing dimension by using Excel. Similarly, I employed statistical graphics in the analyses for exploring relationship in a large data set (Chamber et al., 1983). I employed stacked bar charts to visualize the relationship between stance and other noticing dimensions. The stacked bar charts showed percentages of the idea units associated with different stances and different categories in each noticing dimension. The bigger areas in the stacked bar charts showed a particular category that had more of a relationship with a particular stance.

A summary of the statistical analyses used in my study is shown in Table 3.4.

Table 3.4

A Summary of the Statistical Analyses Used in the Study

Research Question	Statistical Analyses Used to Answer the Research Question
1. What did teacher candidates most frequently notice when they analyzed their teaching?	• Frequencies and percentages of the idea units associated with the categories in the noticing dimensions
2. What was the pattern of teacher candidates' noticing within and across four written reflections?	• Stacked bar charts showing the percentages of the idea units associated with the categories in the noticing dimensions within and across reflections by overall and individual teacher candidates • Measures of center (mean and median) • Standard deviation • Coefficient of variation • Inner-quartile range
3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?	• Frequencies and percentages of the idea units associated with the stances and the categories in other noticing dimensions • Stacked bar charts showing the percentages of the idea units associated with the stances and the categories in other noticing dimensions

Results of these statistical analyses are reported in the next result chapters.

Chapter 4
Results: Noticing Categories and Noticing Patterns

This results chapter addresses the first two research questions of my study:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
2. What was the pattern of teacher candidates' noticing within and across four written reflections?

I analyzed teacher candidates' reflections using the following dimensions: topic, presence of evidence, instructional feature, and stance. This chapter is separated into four sections based on the dimensions and codes. I report here on aggregated and disaggregated teacher candidate data across each reflection. I disaggregated teacher candidates' data within each reflection to report on the (a) frequency of idea units, (b) measures of center (mean and median), (c) variance of the data from the mean or the standard deviation, (d) coefficient of variation, which normalizes the variance facilitating comparisons of standard deviation across codes, and (e) inner-quartile range (quartile one to three) to explain where 50% of the data lie within any code.

My analyses revealed that when teacher candidates talked about teaching, they frequently: (1) focused on the topic of the teacher's instruction; (2) included specific teaching evidence; (3) paid attention to the instructional feature of the teacher, the interaction between the teacher and student, and the interactions among the teacher, student, and content; and (4) interpreted their teaching. Patterns of teacher candidates' noticing were varied within and across four written reflections on instructional activities.

Topic

For the dimension of topic, I used three codes: the teacher's instruction, students' participation, and mathematical content. Coding of these three non-overlapping topics allowed me to inventory the central focus of an idea unit within teacher candidates' reflections. Overall, teacher candidates most frequently focused on the topic of the teacher's instruction in all reflections, with the percent of the idea units ranging from 68.85% in reflection one to 76.60% in reflection four. Approximately a quarter to almost a third of the idea units was within a reflection in which teacher candidates focused on the topics of the students' participation. This percentage ranged from 23.08% in reflection four to 30.98% in reflection one. In a few idea

units, teacher candidates focused on the topic of mathematical content, ranging from 0.54% in reflection one to 1.40% in reflection four.

Overall, teacher candidates' focus on the topic of the teacher's instruction did not change across reflections. All idea units coded as the topic of the teacher's instruction were approximately equal across four reflections. Similarly, teacher candidates' focus on the topics of students' participation did not change very much across reflections. Teacher candidates' focus on the topic of mathematical content was consistently the lowest percentage within a reflection and across all four reflections.

These findings are summarized in Figure 4.1, which shows a comparison of all teacher candidates' topics of focus within the reflections.

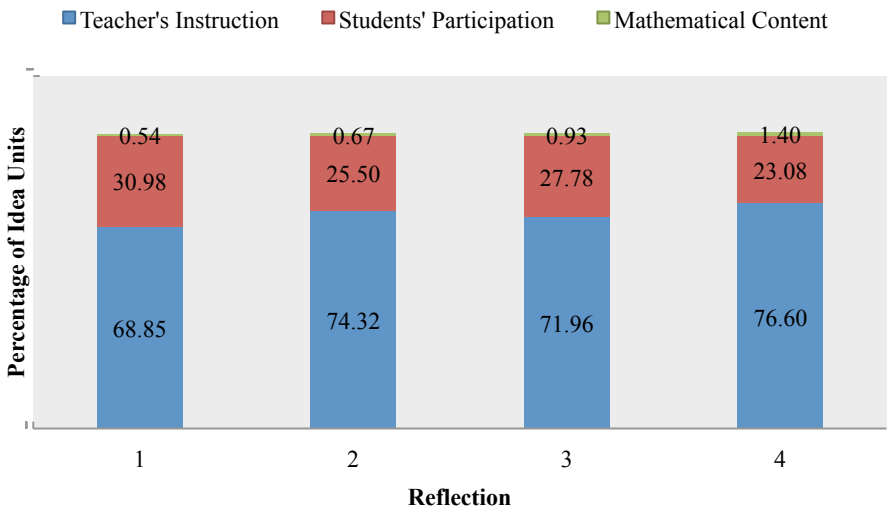

Figure 4.1. Percentages of idea units associated with different topics in each reflection.

Reflection one. Teacher's instruction was the most frequently coded topic for all teacher candidates, ranging from 56.25% to 82.35% in reflection one. The mean (M = 68.29) was higher than the median (Med = 66.67), with a variance of data SD = 8.26, and a CV of 12%. The inner-quartile range of idea units coded with teacher's instruction was 64.71% to 73.03%. Students' participation was the second most frequently coded topic, with a range of 17.65% to 43.75%. The median (Med = 33.33) was higher than the mean (M = 31.29), with a variance of data SD = 8.61, and a CV of 28%. The inner quartile range of idea units coded with students'

participation was 24.70% to 35.29%. TC02 was the only teacher candidate who talked about the topic of mathematical content in reflection one with 4.55% of idea units coded with this topic.

Reflection two. Teacher's instruction was the most frequently coded topic for all teacher candidates, ranging from 57.14% to 83.33% in reflection two. The median (Med = 75.00) was slightly higher than the mean (M = 74.07), with a variance of data SD = 8.85, and a CV of 12%. The inner-quartile range of idea units coded with teacher's instruction was 70.98% to 80.63%. Students' participation was the second most frequent coded topic, with a range of 16.67% to 42.86%. The mean (M = 25.23) was higher than the median (Med = 23.08), with a variance of data SD = 8.73, and a CV of 35%. The inner-quartile range of idea units coded with students' participation was 19.38% to 26.14%. TC04 is the only teacher candidate who talked about the topic of mathematical content in reflection two (7.69%).

Reflection three. Teacher's instruction was the most frequently coded topic for all teacher candidates, ranging from 50.00% to 88.89% for reflection three. The mean (M = 69.64) was higher than the median (Med = 66.67), with the variance of the data SD = 12.04, and a CV of 17%. The inner-quartile range of idea units coded with teacher's instruction was 61.82% to 80.63%. Students' participation was the second most frequently coded topic, with a range of 11.11% to 50.00%. The median (Med = 30.00) was higher than the mean (M = 29.35), with a variance of data SD = 12.23, and a CV of 42%. The inner-quartile range of idea units coded with students' participation was 19.38% to 38.18%. Teacher candidate TC09 had 11.11% of the idea units coded with mathematical content.

Reflection four. Teacher's instruction was the most frequently coded topic for all teacher candidates, ranging from 52.94% to 93.33% in reflection four. The median (Med = 77.78) was higher than the mean (M = 74.67), with the variance of the data SD = 13.39, and a CV of 18%. The inner-quartile range of idea units coded with teacher's instruction was 65.16% to 83.22%. Students' participation was the second most frequently coded topic, with a range of 6.67% to 47.06%. The mean (M = 23.68) was higher than the median (Med = 20.00), with the variance of the data SD = 13.01, and a CV of 55%. The inner-quartile range of the idea units coded with students' participation was 16.78% to 27.78%. Teacher candidates TC01 had 18.18% of the idea units coded with mathematical content.

These findings are reported in Figure 4.2, which shows a comparison of each teacher candidate's topic of focus in four reflections.

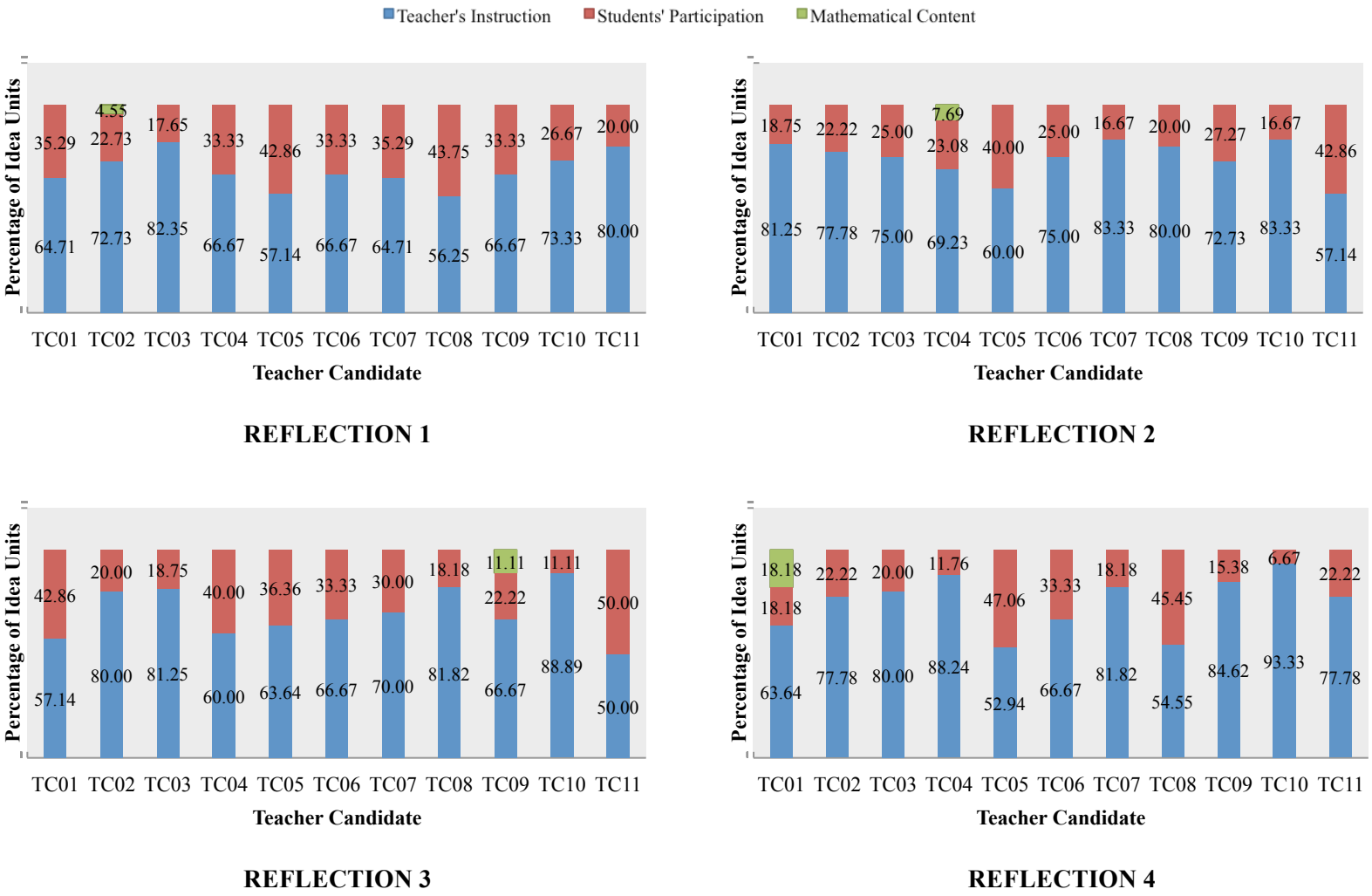

Figure 4.2. Percentages of idea units associated with different topics in each reflection by each teacher candidate.

Looking across the four reflections, I found that teacher candidates tended to notice teacher's instruction and students' participation in a ratio ranging approximately from 3:1 to 2:1. The normalized variance (coefficient of variation: CV) across reflections shifted for the topic of the teacher's instruction and students' participation. From reflections one to two, greater focus was given to the topic of the teacher's instruction as shown by the shift in the means and inner-quartile range values. Conversely, less focus was given to students' participation from reflections one to two, but these data varied more in reflection two than in reflection one, as noted by the change in normalized variance. In reflection three, the mean scores of the teacher's instruction and students' participation, as topics, were similar to the respective means in reflection one. However, the normalized variance for students' participation data continued to increase across reflections one to three. Conversely, the normalized variance for the topic of teacher's instruction shifted between reflections two to three and three to four, but it remained the same for reflections one to two. In reflection four, the means for the topics of teacher's instruction and students' participation were similar to the respective means in reflection two. However, the normalized variance for students' contribution continued to increase from reflections three to four, while the normalized variance for instruction stayed about the same. The within-topic (teacher's instruction and students' participation) and across-reflection measures of center (mean and median) were similar for reflections one and three and reflections two and four.

What is conspicuously absent in the data is a focus on mathematical content as the central topic of the idea units for any teacher candidate across all reflections. Overall, these data suggest that the variance of data coded with the topic of teacher's instruction varied less than did data coded with the topic of students' participation across reflections. Further, the measures of center were consistently higher for the teacher's instruction than for students' participation.

Presence of Evidence

In this section, I explain how teacher candidates included or did not include specific evidence to support their claims as their reflections. Overall, teacher candidates included evidence across each reflection, ranging from 68.53% to 84.26%. In approximately a fifth to a third of idea units, teacher candidates did not include evidence, ranging from 15.74% to 31.47%. The shift in the use of evidence within idea units increased from reflections one to three and then

decreased in reflection four. The shift in idea units coded with no evidence decreased from reflections one to three and then doubled from reflections three to four.

These findings are summarized in Figure 4.3, which shows a comparison of the percentages of idea units with evidence and no evidence within each reflection.

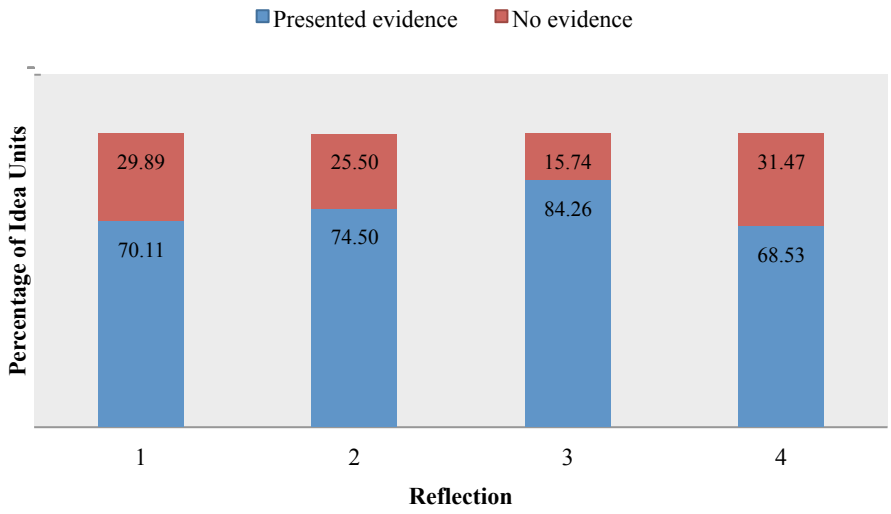

Figure 4.3. Percentages of the idea units associated with different the presence of evidence in each reflection.

Reflection one. A majority of teacher candidates (10 of 11) used evidence in greater percentages versus no evidence in reflection one. Idea units coded with evidence ranged from 64.29% to 93.75%. The mean (M = 72.18) was higher than the median (Med = 69.70), with the variance of data SD = 12.23, and a CV of 12%. The inner-quartile range of ideas units coded with evidence was 64.71% to 78.33%. Idea units coded with no evidence ranged from 6.25% to 46.67%. The median (Med = 30.30) was higher than the mean (M = 27.82), with variance of data SD = 12.23, and a CV of 44%). The inner-quartile range of ideas units coded with no evidence was 21.67% to 35.29%. Of the teacher candidates, TC11 was one who had a greater percentage of ideas units coded without evidence than with evidence.

Reflection two. All teacher candidates had a greater percentage of ideas units coded with evidence than without evidence. Idea units coded with evidence ranged from 62.50% to 92.31%. The mean (M = 75.24) was higher than the median (Med = 72.22), with the variance of data SD = 11.24, and a CV of 15%. The inner-quartile range of ideas units coded with evidence was 66.67% to 78.33%. In contrast, the idea units coded without evidence ranged from 7.69% to 37.50%. The median (Med = 27.78) was higher than the mean (M = 24.76), with the variance of

data SD = 11.24, and a CV of 37%. The inner-quartile range of ideas units coded without evidence was 16.54% to 33.33%.

Reflection three. Similar to reflection two in reflection three, all teacher candidates had a greater percentage of idea units coded with evidence than without evidence. Idea units coded with evidence ranged from 72.73% to 90.91%. The median (Med = 85.71) was higher than the mean (M = 84.16), with the variance of data SD = 5.87, with a CV of 7%. The inner-quartile range of ideas units coded with evidence was 80.00% to 78.33%. In approximately less than a third of idea units, teacher candidates did not include evidence ranging from 9.09% to 27.27%. The mean (M = 15.84) was higher than the median (Med = 14.29), with the variance of data SD = 5.87, and a CV of 37%. The inner-quartile range of ideas units coded without evidence was 11.11% to 20.00%.

Reflection four. A majority of teacher candidates (10 of 11) used evidence in greater percentages versus no evidence in reflection four. Idea units coded with evidence ranged from 61.11% to 88.89%. The median (Med = 72.73) was higher than the mean (M = 72.06), with the variance of data SD = 7.39, with a CV of 10%. The inner-quartile range of ideas units coded with evidence was 67.31% to 73.18%. In contrast, the idea units coded without evidence ranged from 11.11% to 38.89%. The mean (M = 27.94) was slightly higher than the median (Med = 27.27), with the variance of data SD = 7.39, and a CV of 26%. The inner-quartile range of ideas units coded without evidence was 26.82% to 32.69%. Of the teacher candidates, TC04 was one who had a greater percentage of idea units coded without evidence than with evidence.

A reporting of these findings is in Figure 4.4, which shows a comparison of the percentages of idea units with evidence and no evidence in four reflections.

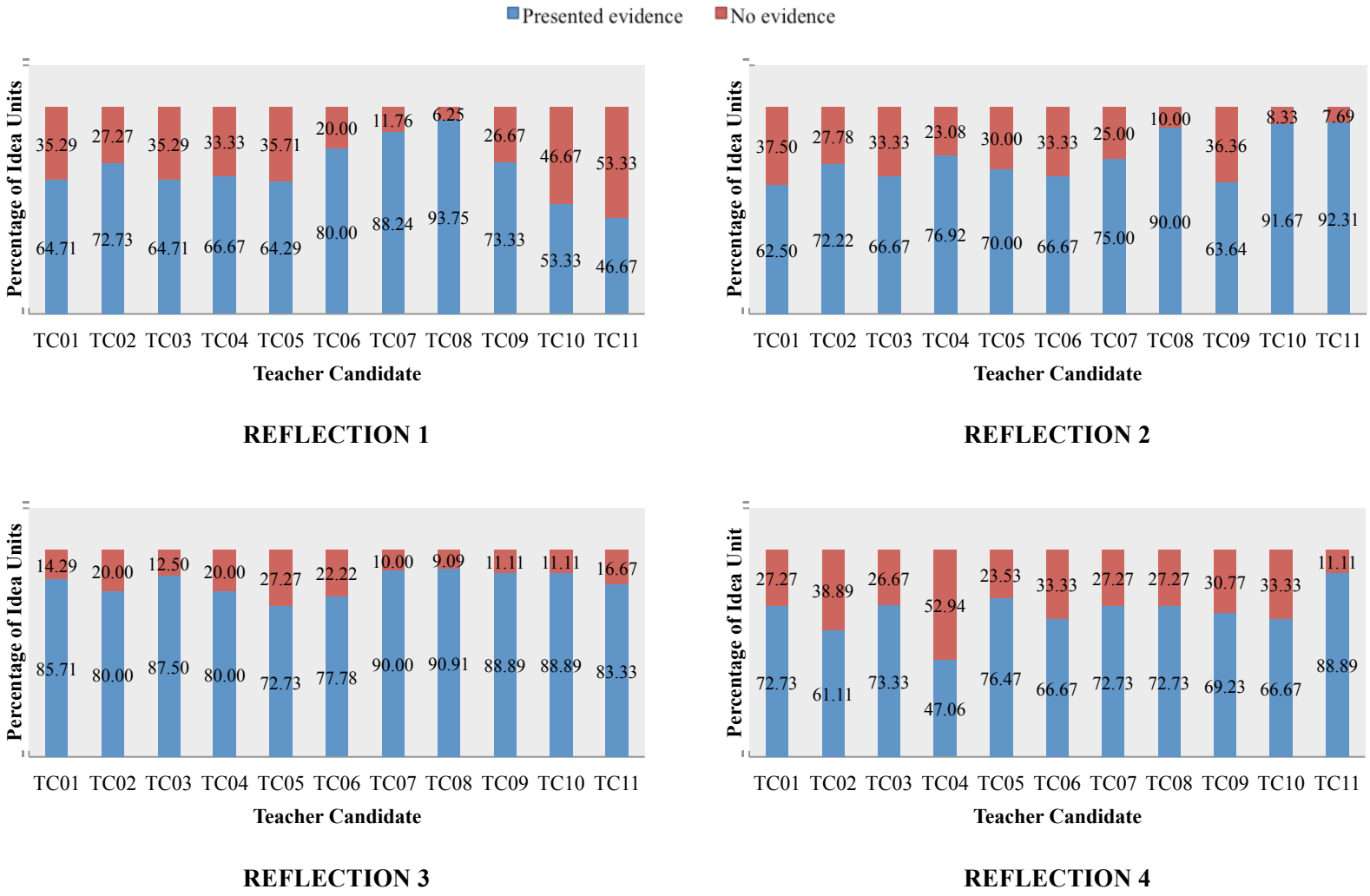

Figure 4.4. Percentages of idea units associated with different the presence of evidence in each reflection by each teacher candidate.

Looking across the four reflections, I found that teacher candidates tended to include evidence more often than they did not include evidence in their analyses of classroom teaching, in a ratio ranging from approximately 5:1 to 2:1. The normalized variance (coefficient of variation: CV) across reflections shifted for the presence of evidence and no evidence. However, the CV for the presence of evidence changed less across reflections than it did for the data coded with no evidence. From reflections one to two, a greater percentage of idea units showed the use of evidence versus not using evidence, as shown by the shift in means and inner-quartile range values. In reflection three, the mean score for the presence of evidence was higher than the means in reflections one and two. The normalized variance for the data with evidence continued to decrease across reflections one to three. Conversely, the mean score for no evidence was lower than the means in reflections one and two. The CV for idea units coded with no evidence was decreased from reflections one to two and was consistent in reflections two and three. In reflection four, the means for the presence of evidence and no evidence were similar to the respective means in reflection one. However, the normalized variance for the data with evidence slightly increased from reflections three to four, but the normalized variance for the data without evidence continued to decrease from reflections two to four. The within-code (presence of evidence and no evidence) and across-reflection measures of center (mean and median) were similar for reflections one, two, and four. Overall, these data suggest that the variance of data coded with the presence of evidence varied less and had higher measures of center than did data coded with no evidence across the reflections.

Instructional Feature

In this section, I explain the instructional features to which teacher candidates frequently paid attention when they talked about classroom teaching. Overall, the first three instructional features to which all teacher candidates frequently paid attention were the teacher, the interaction of the teacher and student, and the interaction of the teacher, student, and content. However, the trends of teacher candidates' attention to instructional features in each reflection were different. For reflection one, the teacher candidate group frequently paid attention to the teacher (35.87%), the interaction of the teacher and student (32.07%), and the interaction of the teacher, student, and content (23.50%), respectively. In reflections two and four, similar to reflection one, the teacher candidate group most frequently paid attention to the teacher (reflection two: 32.89%; reflection four: 37.06%). Then, they paid attention to the interaction of the teacher, student, and

content (reflection two: 32.41%; reflection four: 32.87%) and the interaction of the teacher and student (reflection two: 21.48%; reflection four: 20.98%). In reflection three, teacher candidates paid attention to the interaction of the teacher, student, and content (43.27%), the teacher (25.93%), and the interaction of the teacher and student (20.37%).

A summary of these results is in Figure 4.5, which shows a comparison of all teacher candidates' attention to different instructional features within each reflection.

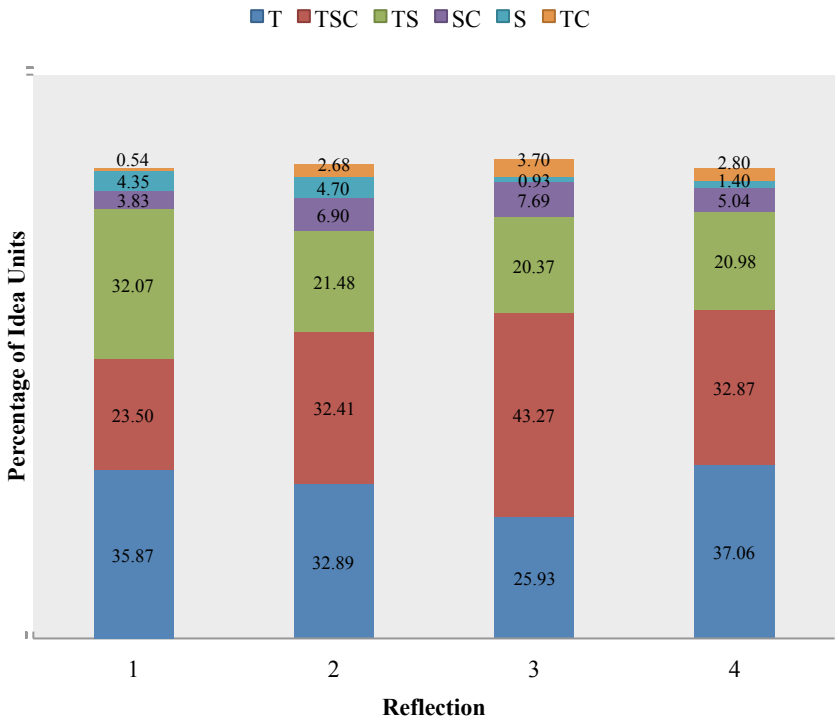

Figure 4.5. Percentages of idea units associated with different instructional features in each reflection.

Because a majority of teacher candidates paid attention to the teacher, the interaction of the teacher and student, and the interaction of the teacher, student, and content, I specifically explored each teacher candidate's attention to these instructional features within each reflection.

Reflection one. Attention to instructional features varied across teacher candidates. Idea units coded with teacher ranged from 18.75% to 53.33%. The mean (M = 35.42) was higher than the median (Med = 33.33), with the variance of data SD = 11.93, and a CV of 34%. The inner-quartile range of ideas units coded with teacher was 28.04% to 44.12%. Idea units coded with the interaction of the teacher and student ranged from 6.67% to 52.94%. The

median (Med = 31.82) was slightly higher than the mean (M = 31.34), with the variance of data SD = 12.39, and a CV = 40%. The inner-quartile range of idea units coded with the interaction of the teacher and student was 26.67% to 38.24%. Idea units coded with the interaction of the teacher, student, and content ranged from 0.00% to 62.50%. The mean (M = 23.63) was higher than the median (Med = 20.00), with the variance of data SD = 17.46, and a CV of 74%. The inner-quartile range of idea units coded with the interaction of the teacher, student, and content was 12.40% to 32.58%.

Reflection two. Similar to reflection one, attention to instructional features varied across teacher candidates. Idea units coded with teacher ranged from 10.00% to 50.00%. The median (Med = 36.36) was higher than the mean (M = 31.87), with the variance of data SD = 13.14, and a CV of 41%. The inner-quartile range of ideas units coded with the teacher was 20.84% to 40.84%. Idea units coded with the interaction of teacher and student ranged from 0.00% to 38.46%. The median (Med = 23.08) was higher than the mean (M = 21.74), with the variance of data SD = 12.14, and a CV = 56%. The inner-quartile range of idea units coded with the interaction of the teacher and student was 13.89% to 31.67%. Idea units coded with the interaction of the teacher, student, and content ranged from 5.00% to 50.00%. The median (Med = 37.50) was higher than the mean (M = 32.10), with the variance of data SD = 14.33, and a CV of 45%. The inner-quartile range of idea units coded with the interaction of the teacher, student, and content was 21.59% to 43.06%.

Reflection three. Attention to instructional features varied across teacher candidates. Idea units coded with teacher ranged from 14.29% to 44.44%. The mean (M = 25.78) was higher than the median (20.00), with the variance of data SD = 10.63, and a CV of 41%. The inner-quartile range of idea units coded with teacher was 19.09% to 30.30%. Idea units coded with the interaction of the teacher and student ranged from 0.00% to 44.44%. The median (Med = 22.22) was higher than the mean (M = 18.93), with the variance of data SD = 15.75, and a CV of 83%. The inner-quartile range of idea units coded with the interaction of the teacher and student was 4.55% to 30.00%. Idea units coded with the interaction of the teacher, student, and content ranged from 0.00% to 71.43%. The median (Med = 43.75) was higher than the mean (M = 42.76), with the variance of data SD = 22.57, and a CV of 53%. The inner-quartile range of idea units coded with the interaction of the teacher, student, and content was 30.30% to 60.01%.

Reflection four. Similar to the previous reflections, attention to instructional features varied across teacher candidates. Idea units coded with teacher ranged from 23.53% to 64.71%. The mean (M = 36.33) was higher than the median (Med = 33.33), with the variance of data SD = 11.54, and a CV of 32%. The inner-quartile range of idea units coded with teacher was 27.27% to 40.00%. Idea units coded with the interaction of the teacher and student ranged from 0.00% to 46.15%. The median (Med = 17.65) was slightly higher than the mean (M = 17.63), with the variance SD = 15.77, and a CV of 89%. The inner-quartile range of idea units coded with the interaction of the teacher and student was 3.18% to 24.75%. Idea units coded with the interaction among the teacher, student, and content ranged from 5.88% to 66.56%. The median (Med = 36.36) was higher than the mean (M = 35.01), with the variance SD = 19.09, and a CV of 55%. The inner-quartile range of idea units coded with the interaction of the teacher, student, and content was 23.64% to 47.26%

These findings are reported in Figure 4.6, which shows a comparison of each teacher candidate's attention to different instructional features in four reflections.

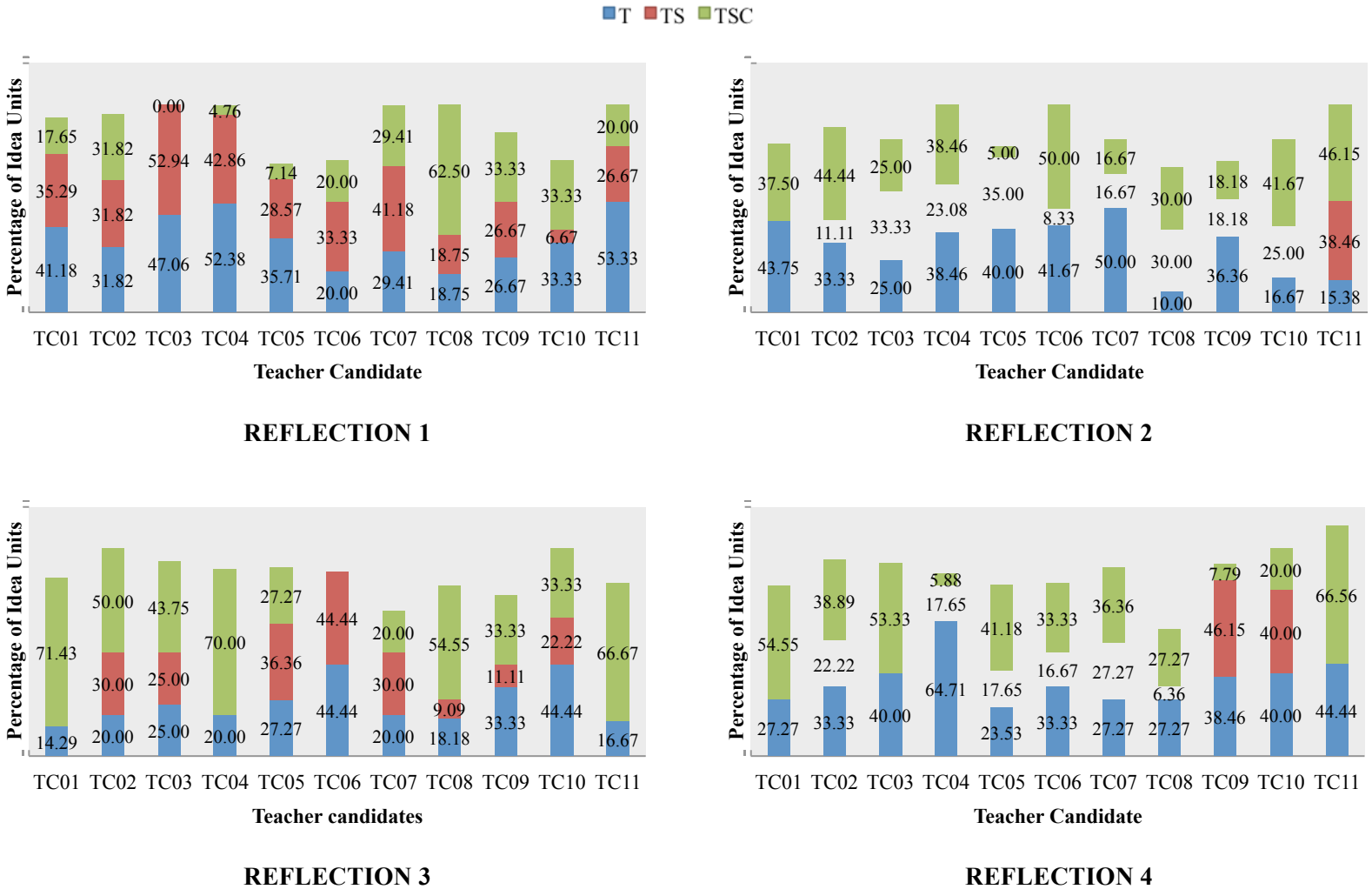

Figure 4.6. Percentages of idea units associated with different instructional features in each reflection by each teacher candidate.

Looking across reflections, I found that teacher candidates' attention to the teacher, the interaction of the teacher and student, and the interaction of the teacher, student, and content varied across reflections. The normalized variance (coefficient of variation: CV) across reflections shifts for the instructional feature of teacher, the interaction of the teacher and student, and the interaction of the teacher, student, and student. However, the CV for the instructional feature of the teacher changed less than it did those for the interaction of the teacher and student and the interaction of the teacher, student, and content. From reflections one to three, idea units coded with the teacher decreased, as shown by the shift in means and inner-quartile range values for this instructional feature. Additionally, there was a decrease in attention to the interaction of the teacher and student, but these data varied more across reflections one to three as noted by the change in normalized variance. Conversely, there was increased attention to the interaction of the teacher, student, and content across reflections one to three. Further, the normalized variance for the interaction of the teacher, student, and content decreased across reflections one to three. In reflection four, the mean and the CV for attention to the teacher were approximately similar to those in reflection one. The normalized variance for the attention to the teacher shifted between reflections one to two and reflections three to four, but it remained the same for reflections two to three. Additionally, the mean for the interaction of the teacher and student in reflection four was approximately similar to the mean in reflection three. The normalized variance for the interaction of the teacher and student continued to increase across reflections one to four. Conversely, the mean for idea units coded with the interaction of the teacher, student, and content in reflection four was approximately similar to the mean in reflection two. However, the normalized variance for the interaction of the teacher, student, and content shifted between reflections one to two and reflections two to three, although it remained about the same for reflections three to four. Overall, these data suggested that teacher candidates showed more attention to the interaction of the teacher, student, and content over time from reflections one to three. They increased their noticing of the complexity of classroom teaching. The data coded with the interaction of the teacher, student, and content continued to increase as evidenced by the measures of center from reflections one to three. The variance of data coded with the interaction of the teacher, student, and content continued to decrease from reflections one to three.

Stance

To explain the analytic stances that teacher candidates took as they analyzed their teaching, I paid attention to five main codes: describe, evaluate, interpret, offer teaching alternative, and offer personal perspective. As described in Chapter Three, the stances of describe and interpret were discrete codes, and the remaining codes were used in conjunction with either of these two codes. As a result, the total percentages of idea units with these five main codes exceeded 100%. In this section, I report on the analytic stances the population of teacher candidates and each teacher candidate took across each reflection.

Overall, teacher candidates most frequently took an interpret stance across the reflections, ranging in idea units from 55.98% in reflection one to 75.93% in reflection three. Evaluate was the second stance teacher candidates frequently took across each reflection. In each reflection, there were approximately a quarter to almost a third of idea units in which teacher candidates took an evaluate stance, ranging from 23.15% in reflection three to 32.07% in reflection one. Describe was the third stance that teacher candidates frequently took in reflections one, two, and three. In these reflections, there were approximately a quarter of the idea units in which teacher candidates used the describe stance, ranging from 22.15% in reflection two to 27.71% in reflection one. The fourth stance that teacher candidates frequently took in reflections one, two, and four was to offer personal perspectives, ranging in idea units from 13.99% in reflection four to 25.54% in reflection one. The stance that overall teacher candidates least frequently took in reflections one, two, and four was to offer teaching alternatives, ranging in idea units from 6.99% in reflection four to 14.09% in reflection two. However, the stance of offering teaching alternatives was the third most frequent stance teacher candidates took in reflection four, with the idea units at 18.52%. The fourth and the last, stances that teacher candidates frequently took in reflection three were to offer personal perspectives and describe with idea units, at 13.89% and 8.33%, respectively.

Looking across four reflections, how overall teacher candidates used these five stances did not change across reflections one, two, and four. All idea units coded with the stances of interpret, evaluate, describe, offer personal perspective, or offer teaching alternative were approximately consistent across reflections one, two, and four. However, how teacher candidates used these five stances was different in reflection three. In reflection three, teacher candidates shifted how they used the three stances of describe, perspective, and alternative.

A summary of these findings is shown in Figure 4.7, which provides a comparison of the percentages of the idea units associated with different stances in each reflection.

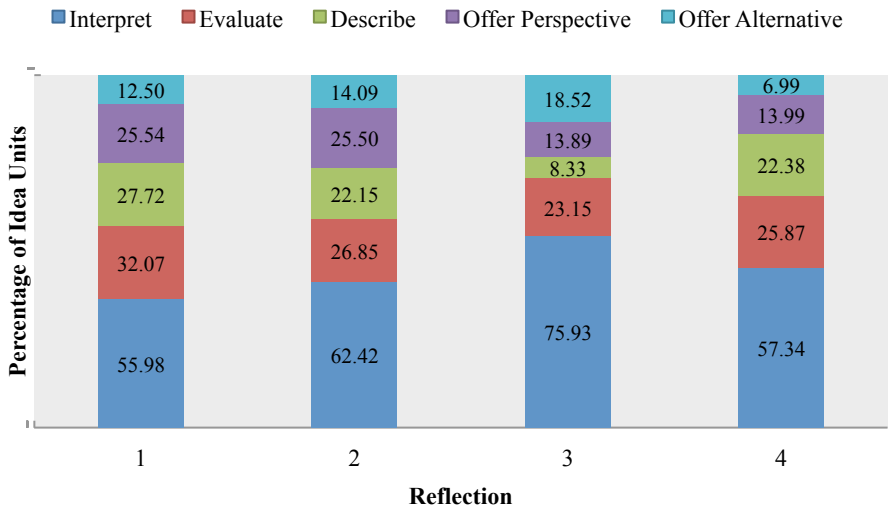

Figure 4.7. Percentages of idea units associated with different stances in each reflection.

Reflection one. Stances were taken differently across each teacher candidate. Idea units coded with an interpret stance ranged from 40.00% to 81.25%. The mean (M = 53.80) was slightly higher than the median (Med = 53.33), with the variance of data SD = 11.60, and a CV of 22%. The inner-quartile range of idea units coded with an interpret stance was 46.87% to 55.85%. Idea units coded as an evaluate stance ranged from 11.76% to 47.06%. The median (Med = 35.29) was higher than the mean (M = 31.86), with the variance of data SD = 12.40, and a CV of 39%. The inner-quartile range of idea units coded with an evaluate stance was 23.22% to 40.00%. Idea units coded with a describe stance ranged from 9.09% to 47.06%. The mean (M = 28.80) was higher than the median (Med = 25.53), with the variance of data SD = 12.61, and a CV of 44%. The inner-quartile range of idea units coded with a describe stance was 20.24% to 40.00%. Idea units coded with an offer personal perspective stance ranged from 5.88% to 47.06%. The mean (M = 24.69) was higher than the median (Med = 20.00), with the variance of data SD = 15.55, and a CV of 63%. The inner-quartile range of idea units coded with an offer personal perspective stance was 13.33% to 36.51%. Lastly, idea units coded with an offer teaching alternative stance ranged from 0.00% to 26.67%. The median (Med = 13.33) was higher than the mean (M = 12.65),

with the variance of data SD = 8.79, and a CV of 70%. The inter-quartile range of idea units coded with an offer teaching alternative stance was 6.81% to 18.47%.

Reflection two. Similar to reflection one, stances were differently taken across each teacher candidate. Idea units coded with an interpret stance ranged from 41.67% to 83.33%. The median (Med = 63.64) was slightly higher than the mean (M = 63.35) with the variance of data SD = 13.31, and a CV of 21%. The inner-quartile range of idea units coded with an interpret stance was 55.91% to 71.80%. Idea units coded as an evaluate stance ranged from 15.00% to 53.85%. The mean (M = 27.38) was higher than the median (Med = 25.00), with the variance of data SD = 12.49, and a CV of 46%. The inner-quartile range of idea units coded with an evaluate stance was 17.43% to 33.33%. Idea units coded with a describe stance ranged from 0.00% to 46.15%. The median (Med = 25.00) was higher than the mean (M = 20.51), with the variance of data SD = 15.33, and a CV of 75%. The inner-quartile range of idea units coded with a describe stance was 8.34% to 30.63%. Idea units coded with an offer personal perspective stance ranged from 10.00% to 40.00%. The median (Med = 25.00) was slightly higher than the mean (M = 24.61), with the variance of data SD = 8.64, and a CV of 35%. The inner-quartile range of idea units coded with an offer personal perspective stance was 18.47% to 30.77%. Lastly, idea units coded with an offer teaching alternative stance ranged from 0.00% to 30.77%. The mean (M = 14.30) was higher than the median (Med = 8.33), with the variance of data SD = 11.10, and a CV of 78%. The inter-quartile range of idea units coded with an offer teaching alternative stance was 8.01% to 23.64%.

Reflection three. Stances were taken differently across each teacher candidate. Idea units coded with an interpret stance ranged from 55.56% to 90.00%. The median (Med = 77.78) was higher than the mean (M = 74.87), with the variance of data SD = 10.72, and a CV of 14%. The inner-quartile range of idea units coded with an interpret stance was 70.84% to 80.91%. Idea units coded as an evaluate stance ranged from 0.00% to 54.55%. The mean (M = 23.64) was higher than the median (Med = 22.22), with the variance of data SD = 14.41, and a CV of 61%. The inner-quartile range of idea units coded with an evaluate stance was 14.59% to 30.00%. Idea units coded with a describe stance ranged from 0.00% to 22.22%. The median (Med = 9.09) was higher than the mean (M = 8.37), with the variance of data SD = 8.10, and a CV of 97%. The inner-quartile range of idea units coded with a describe stance was 0.00% to 12.70%. Idea units coded with an offer personal perspective stance ranged from 9.09% to 22.22%. The mean

(M = 14.11) was higher than the median (Med = 12.50), with the variance of data SD = 4.51, and a CV of 32%. The inner-quartile range of idea units coded with an offer personal perspective stance was 10.56% to 17.43%. Lastly, idea units coded with an offer teaching alternative stance ranged from 0.00% to 40.00%. The median (Med = 22.22) was higher than the mean (M = 18.36), with the variance of data SD = 13.20, and a CV of 72%. The inter-quartile range of idea units coded with an offer teaching alternative stance was 8.34% to 26.14%.

Reflection four. Similar to the previous reflections, stances were taken differently across each teacher candidate. Idea units coded with an interpret stance ranged from 35.29% to 76.47%. The mean (M = 57.51) was higher than the median (Med = 55.56), with the variance of data SD = 11.23, and a CV of 20%. The inner-quartile range of idea units coded with an interpret stance was 53.60% to 65.16%. Idea units coded as an evaluate stance ranged from 5.88% to 46.67%. The mean (M = 25.66) was higher than the median (Med = 22.22), with the variance of data SD = 12.72, and a CV of 50%. The inner-quartile range of idea units coded with an evaluate stance was 17.43% to 36.36%. Idea units coded with a describe stance ranged from 6.67% to 47.06%. The mean (M = 23.00) was higher than the median (Med = 17.65), with the variance of data SD = 15.13, and a CV of 66%. The inner-quartile range of idea units coded with a describe stance was 16.03% to 31.31%. Idea units coded with an offer personal perspective stance ranged from 0.00% to 26.67%. The mean (M = 13.12) was higher than the median (Med = 11.76), with the variance of data SD = 7.54, and a CV of 58%. The inner-quartile range of idea units coded with an offer personal perspective stance was 9.09% to 17.16%. Lastly, idea units coded with an offer teaching alternative stance ranged from 0.00% to 18.18%. The mean (M = 6.63) was higher than the median (Med = 5.88), with the variance of data SD = 7.08, and a CV of 107%. The inter-quartile range of idea units coded with an offer teaching alternative stance was 0.00% to 12.22%.

These findings are reported in Figure 4.8, which shows a comparison of each teacher candidate's taking of different stances in four reflections.

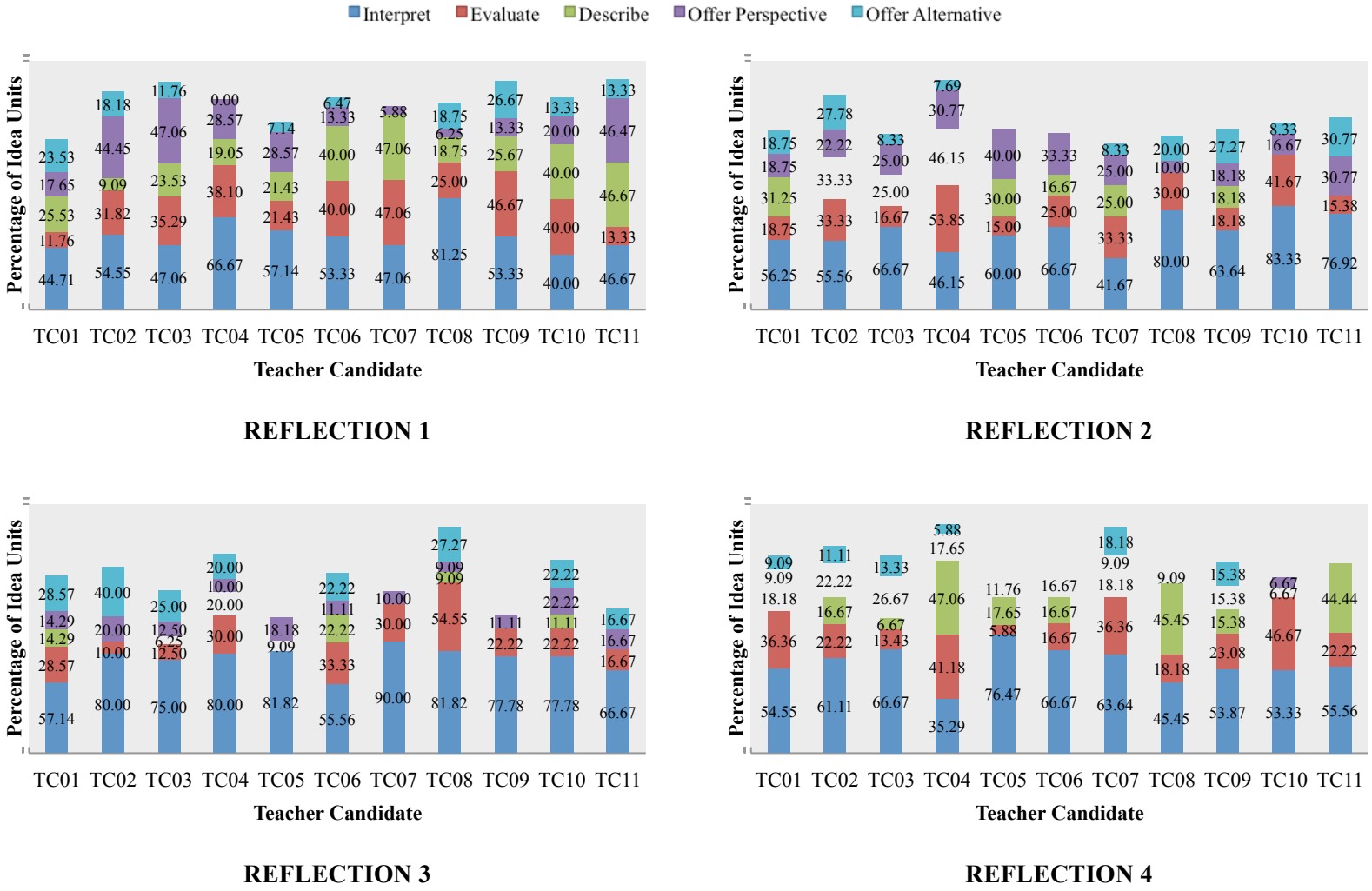

Figure 4.8. Percentages of idea units associated with different stances in each reflection by each teacher candidate.

Looking across reflections, I found that teacher candidates' taking of stances varied across reflections. The normalized variance (coefficient of variation: CV) across reflections shifted for the stances of interpret, evaluate, describe, offer personal perspective, and offer teaching alternative. However, the CV for the stance of interpret changed less across reflections than did those for other stances. From reflections one to three, there was a greater taking of the interpret stance and an offer teaching alternative stance as shown by the shifts in the means and inner-quartile range values. The data with an offer teaching alternative varied more than did those with an interpret stance from reflections one to three. Conversely, there was less taking of an evaluate stance, a describe stance, and an offer personal perspective stance from reflections one to three. The normalized variances for the stance of evaluate and describe increased across reflections one to three, but that for the stance of offer personal perspective decreased across reflections one to three. In reflection four, the mean and the CV for the taking of an interpret stance was approximately similar to the CV in reflection one. The normalized variance for an interpret stance shifted between reflections two and three and reflections three and four, but it remained the same for reflections one and two. In contrast, the means for an evaluate stance and a describe stance in reflection four increased from the mean in reflection three. The normalized variance for these stances continued to increase from reflections one to three, but it shifted from reflections three to four. However, the mean for the offer personal perspective stance in reflection four was approximately similar to that in reflection three. The normalized variance for an offer personal perspective stance continued to decrease from reflections one to three, but it shifted from reflections three to four. Lastly, the mean for the offer teaching alternative stance in reflection four was the lowest. The data with an offer teaching alternative stance in reflection four also showed the highest variance. Thus, the normalized variance for an offer teaching alternative stance continued to increase from reflections one to four. Overall, these data suggest that teacher candidates took more of an interpret stance than they did other stances. Also, teacher candidates consistently interpreted situations in video clips. The variance of data coded with an interpret stance varied less and had higher measures of center than did data coded with other stances across the reflections.

Summary

In summary, how teacher candidates focused on topics and included evidence were consistent across each reflection. Teacher candidates frequently focused on the topic of the teacher's instruction. Four of 11 teacher candidates showed consistent attention to this topic across the four reflections. Teacher candidates tended to include more evidence than not include evidence as they talked about their classroom teaching. One teacher candidate shifted from not including evidence to including evidence across four reflections. Teacher candidates' noticing shifted from the teacher as an individual instructional feature to the interactions of the teacher and student and of the teacher, student, and content across the reflections. Ten of 11 teacher candidates used an interpretive stance most frequently when they analyzed teaching across each reflection. They interpreted teaching rather than describing teaching. In the next chapter, I present the results on the relationship between stance and other noticing dimensions.

Chapter 5
Results: Relationships between Stance and Other Dimensions

The results discussed in this chapter answer the third research question: How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions? To answer this question, I compare the stance dimension with the other dimensions—topic, presence of evidence, and instructional features—in my coding scheme. I examine aggregated teacher candidate data for each comparison within and across reflections. The results reported here are from the analyses of the frequencies and percentages of the idea units associated with codes for the stance dimension and codes for the other noticing dimensions.

I segment this chapter into three parts. The first section of this chapter examines comparisons of an analytic stance to the topic of an idea unit. The second section examines comparisons of an analytic stance to the presence of evidence in an idea unit. The last section examines comparisons of an analytic stance to the instructional features discussed in an idea unit. Within each section, I investigate the comparisons within and across the reflections.

In summary, my analyses show that teacher candidates' focus on the topic, the inclusion of evidence, and attention to instructional features varied across stances and reflections. First, almost all of the idea units with the stances of evaluate, describe, or offer personal perspective focused on the topic of the teacher's instruction. In contrast, the topic of students' participation was focused on by approximately a third to a half of the idea units with an interpret stance in all reflections and by approximately a third of those with an offer teaching alternative stance in reflections one, three, and four. Second, almost all of the idea units with the stances of interpret, offer personal perspective, or offer teaching alternative included evidence consistently in all reflections. Approximately 80% of the idea units with an evaluate stance included evidence consistently in reflections one to three. Additionally, approximately a third to a half of those with a describe stance included evidence in reflections one to three. Last, a majority of the idea units with the stances of describe or offer personal perspective paid attention to the teacher in all reflections. These idea units paid less attention to the interaction of the teacher and student and the interaction of the teacher, student, and content in all reflections. Additionally, a majority of the idea units with an evaluate stance paid more attention to the teacher but less attention to the interaction of the teacher and student and the interaction of the teacher, student, and content in reflection four. In contrast, a majority of the idea units with the stances of interpret or offer

teaching alternative paid attention to the interaction of the teacher and student and the interaction of the teacher, student, and content in all reflections.

More details about these results are described in the following sections.

Stance and Topic

To explain the relationship between the stances that teacher candidates took and the topics on which teacher candidates focused as they talked about their teaching, I paid attention to two topics shown in a majority of idea units: the teacher's instruction and students' participation.

Reflection one. Idea units coded with the stance of interpret split attention between the teacher's instruction (49.02%) and students' participation (50.98%). Idea units coded with the stances of personal perspective or describe focused on the topic of the teacher's instruction (approximately 95%) and students' participation (approximately 5%). In contrast, the idea units coded with the stance of offer teaching alternative split attention between the teacher's instruction (69.57%) and students' participation (30.43%).

Reflection two. A hundred percent of the idea units coded with an offer personal perspective stance focused on the topic of the teacher's instruction. Idea units coded with the stances of evaluate and describe focused on the topic of the teacher's instruction (approximately 97%) and students' participation (approximately 3%). In contrast, the idea units coded with the stance of interpret divided attention between the teacher's instruction (59.78%) and students' participation (40.22%).

Reflection three. Similar to reflection two, 100% of the idea units with an offer personal perspective stance in reflection three focused on the topic of the teacher's instruction. In addition, 80% of the idea units with an evaluate stance focused on the topic of the teacher's instruction, and another 20% of the idea units with this stance focused on the topic of students' participation. Idea units coded with the stances of describe focused on the topic of the teacher's instruction (approximately 90%) and students' participation (approximately 10%). In contrast, the idea units coded with the stances of interpret or offer teaching alternative split attention between the teacher's instruction (approximately 70%) and students' participation (approximately 30%).

Reflection four. Similar to reflections two and three, 100% of the idea units with an offer personal perspective stance in reflection four focused on the topic of the teacher's instruction. Almost 100% of the idea units with the stances of evaluate or describe focused on the topic of the teacher's instruction. In contrast, about 60% to 70% of the idea units with the stances

of interpret and offer teaching alternative focused on the topic of the teacher's instruction, and another 30% to 40% of the idea units with these stances focused on the topic of students' participation.

Looking across four reflections, idea units with the stances of evaluate, describe, or offer personal perspective mostly focused on the topic of the teacher's instruction, at approximately 80% to 100% in all reflections. Approximately less than 20% of the idea units with these stances focused on the topic of students' participation in all reflections. In contrast, approximately 40% to 50% of the idea units with the stance of interpret focused on the topic of students' participation, and another 50% to 60% of the idea units with this stance focused on the topic of the teacher's instruction. In addition, approximately 30% of the idea units with the stance of offer teaching alternative focused on the topic of students' participation in reflections one, three, and four. The idea units with an offer teaching alternative stance in reflection two focused less on the topic of students' participation than they did in other reflections.

A summary of these findings is shown in Figure 5.1, which shows a comparison of the percentages of idea units in each stance and each topic in each reflection.

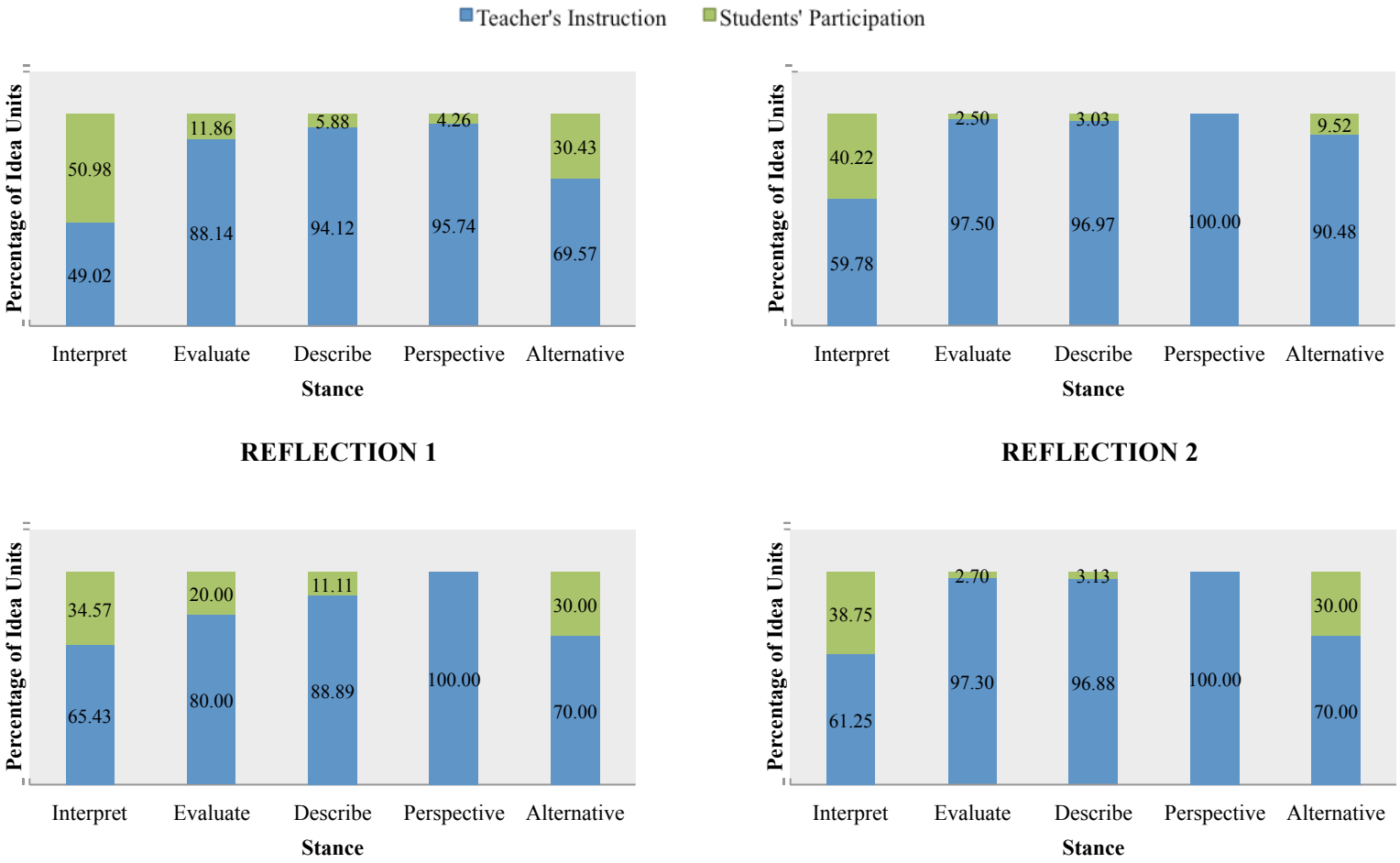

Figure 5.1. Percentages of idea units associated with different stances and topics in each reflection.

Stance and Presence of Evidence

Turning to the comparison of stance to the presence of evidence, I compared idea units coded with the five stances and how evidence was used within each stance.

Reflection one. Approximately 95% of the idea units with the stances of interpret or offer personal perspective used evidence. Further, all idea units with an offer teaching alternative stance used evidence. In contrast, only about half of the idea units with a describe stance used evidence.

Reflection two. All idea units with the stances of interpret, offer personal perspective, or offer teaching alternative used evidence. In contrast, approximately 30% of the idea units with a describe stance used evidence, and 70% of the idea units did not include evidence.

Reflection three. Approximately 99% of the idea units with an interpret stance included evidence. All idea units with the stances of offer personal perspective or offer a teaching alternative used evidence. In contrast, 55.56% of the idea units with a describe stance used evidence, and 44.44% used no evidence.

Reflection four. All idea units with the stances of interpret and offer personal perspective included evidence. Approximately 90% of the idea units with an offer teaching alternative stance included evidence. In contrast, 35.14% of the idea units with an evaluate stance used evidence, and 64.86% used no evidence.

By looking across reflections, more than 90% of the idea units with the stances of interpret, offer personal perspective, and offer teaching alternative included evidence in all reflections. In addition, approximately 70% to 85% of the idea units with an evaluate stance used evidence in reflections one to three. However, the percentage of idea units with an evaluate stance that used evidence decreased to 35.14% in reflection four. In contrast, a majority of idea units without evidence were from idea units with a describe stance. Approximately 45% to 65% of the idea units with the stance of describe in reflections one to three did not include evidence. However, the percentage of idea units with a describe stance that did not use evidence decreased to 20.72% in reflection four.

A summary of these findings is shown in Figure 5.2, which offers a comparison of the percentages of the idea units in each stance and each presence of evidence in four reflections.

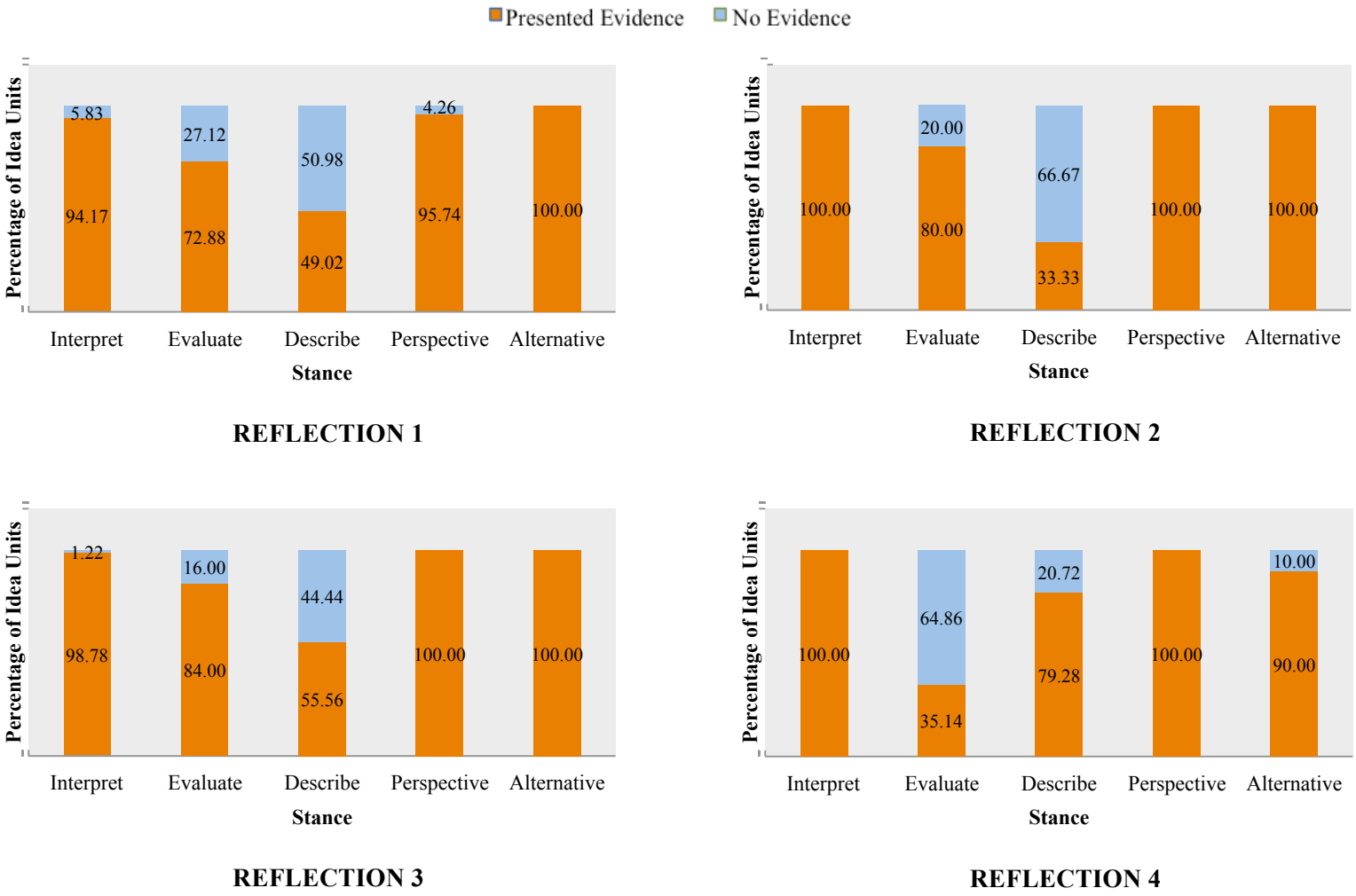

Figure 5.2. Percentages of idea units associated with different stances and the presence of evidence in each reflection.

Stance and Instructional Feature

In this section, I focus on three instructional features that a majority of idea units talked about: (1) the teacher, (2) the interaction of the teacher and student, and (3) the interaction of the teacher, student, and content.

Reflection one. Idea units with the stance of interpret attended to the interaction of the teacher and student at approximately 50% and the interaction of the teacher, student, and content at approximately 40%. Although not as high as interpret, the stances of evaluate and offer teaching alternative attended to the interaction of the teacher and student at 32.14% and 34.93%, respectively, and the interaction of the teacher, student, and content at 19.64% and 19.86%, respectively. Idea units with the stances of evaluate, describe, offer personal perspective, and offer teaching alternative attended to the teacher between at 45.21% and 84.44%. In contrast, approximately 9% of the idea units with the interpret stance paid attention to the teacher. Additionally, the idea units with the stance of describe and offer personal perspective paid less attention to the interaction of the teacher and student, at approximately 15%. The idea units with the stance of offer personal perspective did not pay attention to the interaction among the teacher, student, and content.

Reflection two. Idea units with the stance of interpret attended to the interaction of the teacher and student at approximately 30%, and the interaction of the teacher, student, and content at approximately 60%. The stances of evaluate and offer a teaching alternative attended to the interaction of the teacher and student at 37.84% and 30%, respectively, and the interaction of the teacher, student, and content at 21.62% and 65%, respectively. The idea units with the stances of evaluate, describe, and offer personal perspective attended to the teacher between 40.54% and 81.82%. In contrast, approximately 5% of the idea units with the stances of interpret and offer teaching alternative paid attention to the teacher. In addition, the idea units with the stances of describe and offer personal perspective paid less attention to the interaction of the teacher and student, at approximately 15%. Also, these idea units paid less attention to the interaction of the teacher, student, and content, at approximately less than 5%.

Reflection three. The idea units with the stances of interpret and offer teaching alternative attended to the interaction of the teacher and student at approximately 25%, and the interaction of the teacher, student, and content at approximately 60%. The stance of evaluate attended to the interaction of the teacher and student at 21.74% and the interaction of the teacher, student, and content at 43.48%. The idea units with the stances of describe and offer personal

perspective attended to the teacher at 66.67% and 86.67%, respectively. In contrast, approximately 10% of the idea units with the stances of interpret and offer teaching alternative paid attention to the teacher. Additionally, the idea units with the stance of describe paid less attention to the interaction of the teacher, student, and content, at 11.11%. The idea units with the stance of offer personal perspective did not pay attention to the interaction of the teacher, student, and content.

Reflection four. Idea units with the stances of interpret and offer teaching alternative attended to the interaction of the teacher and student at approximately 30% and to the interaction of the teacher, student, and content at approximately 50%. The stances of evaluate and describe attended to the interaction of the teacher and student at 13.51% and 10.34% respectively, and to the interaction of the teacher, student, and content at 16.22% and 3.45%, respectively. The idea units with the stances of evaluate, describe, and offer personal perspective attended to the teacher at 70.27%, 86.21%, and 95.00%, respectively. In contrast, 4.17% and 20% of the idea units with the stances of interpret and offer teaching alternative paid attention to the teacher. In addition, the idea units with the stance of perspective paid less attention to the interaction of the teacher, student, and content, at 5%. The idea units with this stance did not pay attention to the interaction of the teacher and student.

Looking across four reflections, the stances of evaluate, describe, and offer personal perspective showed the greatest attention to the teacher. This attention mostly increased from reflections one to four. In contrast, the stances of interpret and offer teaching alternative showed the greatest attention to the interaction of the teacher and student and the interaction of the teacher, student, and content in all reflections. The stances of evaluate and offer teaching alternative tended to have a similar trend in attending to the interaction of the teacher and student and the interaction of the teacher, student, and content in reflection one. However, this similarity was not continued across reflections. The stance of offer teaching alternative seemed to pay less attention to the teacher but more attention to the interaction of the teacher and student and the interaction of the teacher, student, and content from reflections one to four. However, the stance of evaluate continued to attend to the interaction of the teacher and student and the interaction of the teacher, student, and content in greater percentages than did the stances of describe and offer personal perspective.

A summary of these findings is shown in Figure 5.3, which offers a comparison of the percentages of idea units in each stance and each presence of evidence in four reflections.

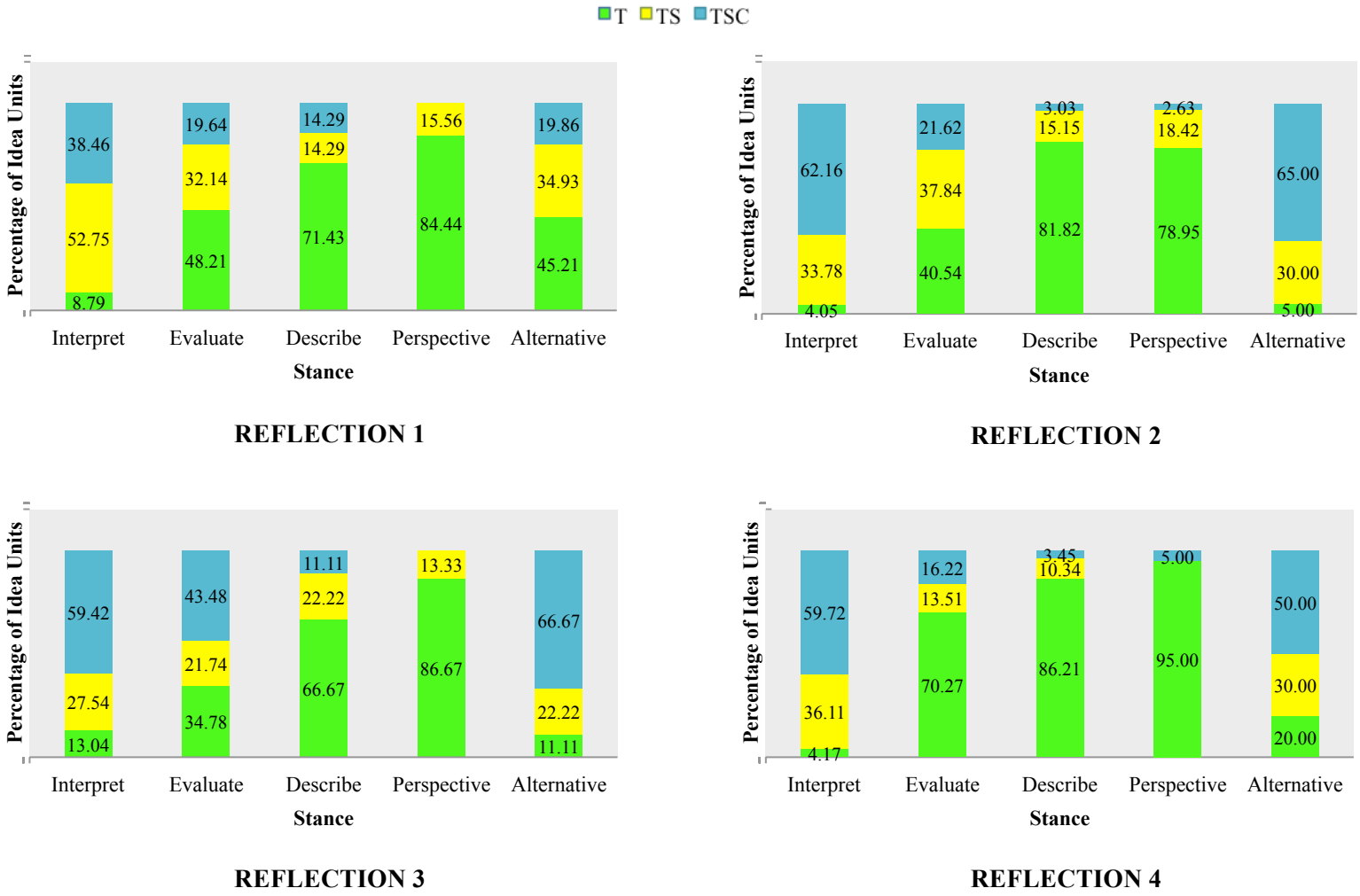

Figure 5.3. Percentages of idea units associated with different stances and instructional features in each reflection.

Summary

In summary, approximately a third to a half of the idea units with an interpret stance focused on the topic of students' participation in all reflections. Almost all of the idea units with this stance included evidence. In addition, almost all of the idea units with an interpret stance paid more attention to the interaction of the teacher and student and the interaction of the teacher, student, and content in all reflections. A majority of the idea units with an evaluate stance focused on the topic of the teacher's instruction in all reflections and included more evidence in reflections one, two, and four. Approximately 40% of the idea units with an evaluate stance paid attention to the teacher in reflections one to three, and approximately 70% of the idea units with this stance paid attention to the teacher in reflection four.

Almost all of the idea units with a describe stance focused on the topic of the teacher's instruction in all reflections. Approximately 30% to 50% of the idea units with a describe stance included evidence in reflections one to three, and almost 80% of the idea units with this stance included evidence in reflection four. A majority of the idea units with this stance paid attention to the teacher in all reflections. Similarly, almost all of the idea units with an offer personal perspective stance focused on the topic of the teacher's instruction in all reflections. Also, almost all of the idea units with this stance included evidence and paid more attention to the teacher in all reflections.

In contrast, approximately 30% of the idea units with an offer teaching alternative focused on the topic of students' participation and another 70% of the idea units with this stance focused on the topic of the teacher's instruction in reflections one, three, and four. However, focus on the topic of the teacher's instruction in reflection two was higher than in other reflections, at approximately 90%. Almost all of the idea units with an offer teaching alternative stance included evidence in all reflections. Approximately half of the idea units with an offer teaching alternative stance paid attention to the teacher, and another half paid attention to the interaction of the teacher and student or the interaction of the teacher, student, and content in reflection one. However, in reflections two to four, a majority of the idea units with this stance paid more attention to the interactions of instructional features, especially the interaction of the teacher, student, and content.

In the next chapter, I synthesize and interpret the results from chapters four and five to discuss patterns of teacher candidates' noticing and the relationships of stance and other noticing dimensions.

Chapter 6
Discussion

The purpose of this study was to examine teacher candidates' noticing of mathematics instruction set within the context of an ambitious teacher education program. Previous research in teacher noticing has advanced that teachers' noticing of student reasoning is important for developing expert noticing. In this study, I built on this recommendation and investigated the nature of teacher candidates' noticing of the instructional system that includes the interactions among the teacher, students, and content. To explore the categories and patterns of teacher candidates' noticing and how teacher candidates analyzed their teaching in relation to other noticing dimensions, I analyzed teacher candidates' written reflections of their classroom teaching. The analyses of these reflections allowed me to document teacher candidates' noticing in four dimensions—topic, presence of evidence, instructional feature, and stance—and to understand the relationships among these dimensions.

In this chapter, I discuss the results from statistical analyses on the categories and patterns of teacher candidates' noticing and on the relationships between stance and other noticing dimensions. I compare the result of my study with the results and suggestions from prior studies on mathematics teacher noticing and I relate the findings from the study to ambitious teaching.

Syntheses of the Results

From the statistical analyses of teacher candidates' reflections, I found that teacher candidates more frequently focused on the topic of the teacher's instruction than other topics and more frequently used evidence in their reflections. Their topics of focus and use of evidence were consistent across reflections. In addition, teacher candidates showed patterns in their attention to the interaction of instructional features and their taking of stances. Teacher candidates increased their attention to the interaction of the teacher, student, and content over time from reflections one to three. Their attention to the interaction of the teacher, student, and content was more consistent over time from reflections one to three. Similarly, teacher candidates' taking of an interpret stance increased over time from reflections one to three. Their interpretation was more consistent over time from reflections one to three.

In addition, I found that teacher candidates who interpreted teaching tended to equally focus on the topics of the teacher's instruction and students' participation. As they interpreted

teaching, teacher candidates mostly included evidence and showed the greatest attention to the interaction of the teacher and student and the interaction of the teacher, student, and content. In addition, as teacher candidates evaluated, described, offered personal perspectives, or offered teaching alternatives, they focused more on the topic of the teacher's instruction than on the topic of students' participation in all reflections. Teacher candidates increased the use of evidence when they evaluated, offered personal perspectives, or offered teaching alternatives from reflections one to three. As teacher candidates described teaching, they used less evidence and paid more attention to the teacher than to the interaction of the instructional features. Similarly, teacher candidates paid more attention to the teacher when they evaluated teaching or offered personal perspectives. Conversely, they paid more attention to the interaction of the teacher and student and the interaction of the teacher, student, and content when they offered teaching alternatives.

In summary, when teacher candidates analyzed teaching, they frequently and consistently noticed important moments in their instruction. They analyzed these instructional moments by interpreting the teaching shown in video clips and used specific evidence from the video clips to support their interpretations. Over time, teacher candidates more frequently noticed the complexity of classroom teaching by increasing the interpretation of the interaction of the teacher, student, and content. However, teacher candidates infrequently attended to offering teaching alternative when they worked on noticing. The protocols used in my study were possibly related to these findings, with similarities to and differences from the findings and suggestions of prior studies. These findings from, relationships with, and comparisons with prior studies are discussed below.

Teacher candidates consistently interpreted their teaching evidence to notice their instruction. Based on the syntheses of my results, I found that teacher candidates' noticing focused more heavily on teacher's instruction as a topic than on students' participation in a ratio ranging approximately from 2:1 to 3:1 across the reflections. The analyses of normalized variance showed that teacher candidates' noticing of the topic of the teacher's instruction varied about the same across reflections; however, for the topic of the students' participation, these data increased in variance across reflections. This suggested that the topic of instruction was a somewhat stable topic of focus across teacher candidates and across reflections. Conversely, the topic of the students' participation was a less stable topic of focus across teacher candidates and across reflections.

The frequent and consistent focus on the topic of the teacher's instruction may be related to how teacher candidates were prompted to reflect on their student rehearsals. Reflection prompts (Appendix B) used to guide teacher candidates asked them to identify a set of high leverage teaching practices. To respond to the initial prompts in the reflection protocol, teacher candidates identified video clips that either showed an enactment of a high leverage teaching practice or the space where a practice could have been used. Candidates were asked to connect specific moments in the video clips to high leverage teaching practices and interpret the contributions of the teacher, students, and mathematics in the clip. Additionally, reflection prompts in parts B and C asked teacher candidates to talk about growth, difficulties, and goals in teaching. The answers to these questions directly tied to the topic of the teacher's instruction. Similarly, the focus on students' participation may be related to how teacher candidates were prompted to reflection on their rehearsals. Reflection prompts in part A (see Appendix B) asked teacher candidates to interpret students' contributions socially and mathematically.

However, teacher candidates were not explicitly asked to talk about mathematical content. The reflection questions in parts A, B, and C did not ask teacher candidates to describe or interpret the mathematical content in the video clips. Teacher candidates were asked to include the talk about mathematical content when they interpreted the teacher's contribution and students' contribution. Thus, teacher candidates used mathematical content as a context when they talked about the teacher's action and students' action.

In addition, I found that teacher candidates more heavily used evidence versus not using evidence in a ratio ranging approximately from 2:1 to 5:1 across the reflections. The analyses of normalized variance showed that teacher candidates' inclusion of evidence varied about the same across reflections. These normalized variance values were less than those of the data without evidence. This suggests that the inclusion of evidence in teacher candidates' reflections on teaching was approximately stable across teacher candidates and across reflections. Conversely, the reflections on teaching without evidence were less stable across teacher candidates and across reflections.

The frequent and consistent use of evidence in reflections on teaching may be related to how teacher candidates were prompted to reflect on teaching. Teacher candidates were asked to connect specific moments in video clips to high leverage teaching practices. As they interpreted the teacher's contribution, students' contribution, and the interplay of these contributions, they were asked to connect their interpretations to particular moments in the selected clips. In

addition, as they talked about teaching growth, difficulties, and goals on the reflection questions in parts B and C, they were asked to include specific moments from their student-teaching, peer rehearsal, or student rehearsal to support their discussion of growth, difficulties, and goals. Thus, the answers to these questions directly tied to their inclusion of evidence.

Lastly, I found that teacher candidates more heavily interpreted teaching than other analytical actions. The analyses of normalized variance showed that teacher candidates' interpretations of teaching varied about the same across reflections. These normalized variance values were also less than those of other stances. This suggests that teacher candidates' interpretations of teaching were approximately stable across teacher candidates and across reflections. Conversely, the normalized variance values of teacher candidates' evaluations and descriptions increased from reflections one to three, those of teacher candidates' offering personal perspectives decreased from reflections one to three, and those of teacher candidates' offering teaching alternatives increased across four reflections.

Similar to the dimensions of topic and evidence in the coding scheme, teacher candidates' taking of an interpret stance may be related to how teacher candidates were prompted to reflect on teaching. Reflection prompts asked teacher candidates to identify clips and explain how they made sense of the teacher's contribution, students' contribution, and the interplay of these contributions in the clips. However, the prompts used in my study asked teacher candidates to take other stances when they analyzed teaching. After transcribing each selected video clip, teacher candidates were asked to describe situations in the video clips by connecting the descriptions to high leverage teaching practices. In addition, teacher candidates were asked to evaluate teaching in the teaching growth and challenge prompts in parts B and C. Based on these prompts, teacher candidates should attend more to the stances of describe and evaluate. Thus, it was interesting that teacher candidates took more of an interpret stance than a describe stance and an evaluate stance.

The results about teacher candidates' topics of focus, use of evidence, and taking of stances to analyze situations in video clips suggest that teacher candidates noticed their instruction by consistent interpreting their teaching evidence. As teacher candidates noticed important moments of classroom teaching in video clips, they frequently and consistently marked the significant moments in their instruction. When teacher candidates talked about these moments, they more frequently interpreted these moments than described, evaluated, offered

personal perspectives, and offered teaching alternatives. Their interpretations of the moments were stable. Their interpretations were specific to evidence in video clips.

The results about the topic of focus in relation to reflection prompts in my study are similar to the findings of prior studies on mathematics teacher noticing. For example, a study by Sherin and van Es (2005) suggested that the use of prompts is effective in guiding teacher candidates' noticing. With the use of prompts guiding attention to a particular topic, teacher candidates in these studies focused more on a particular topic than on other topics. In my study, the teacher candidate reflection prompts asked them to identify specific moments in their instruction linked to a set of high leverage practices. This focus on high leverage practices oriented teacher candidates' narratives to a discussion of their instruction. The entailments of their discussion, although only quantitatively analyzed, showed a movement toward greater attention to the interaction of the teacher, student, and mathematics across the reflections. Thus, it seemed that the frequent focus on the topic of the teacher's instruction in teacher candidates' noticing was related to the reflection prompts.

In contrast, the frequent use of evidence in my study was different from the findings of a study by Sherin and van Es (2005). Sherin and van Es' study found that, based on prompts, teacher candidates could increase "evidence-based comments" in their analyses of classroom teaching. Teacher candidates in their study shifted from general talk about the lesson in videotapes to specific talks or actions by the teacher or students in the videotapes. However, the results of my study only showed that teacher candidates were able to use evidence to support their interpretations of teaching. Their use of evidence seemed to be stable.

Also, the frequent and consistent interpretations of classroom situation differed from the findings of a study by Sherin and van Es (2005). Teacher candidates in their study moved from an evaluative stance to an interpretive stance. In contrast, the results of my study only revealed that teacher candidates were able to interpret teaching situations, as interpretative prompts were provided. Even though the measures of center of an interpret stance were increased and those of an evaluate stance were decreased from reflections one to three, there was no evidence explaining that teacher candidates shifted from evaluating to interpreting.

With the use of prompts in my study, teacher candidates also showed the increase in the complexity of their noticing over time. This finding is discussed in the next sub-section.

The complexity of teacher candidates' noticing increased over time. Based on the syntheses of my results, I found that teacher candidates' noticing focused more on the interaction of the teacher and student and the interaction of the teacher, student, and content than on the instructional feature of the teacher in a ratio ranging approximately from 2:1 to 3:1 across the reflections. The analyses of the inner-quartile range showed that teacher candidates' attention to the interaction of the teacher, student, and content continued to increase from reflections one to three, but little shifted from reflections three to four. In addition, the analyses of normalized variance showed that the variation of attention to the interaction of the teacher, student, and content decreased from reflections one to two and were about the same from reflections two to four. These results suggest that attention to the interaction of the teacher, student, and content, which showed the complexity of teacher candidates' noticing, increased over time.

The complexity of teacher candidates' noticing may be related to how their reflections were prompted. Reflections (Appendix B) used to guide teacher candidates asked them to make sense of the teacher's contribution and students' contribution. Teacher candidates were asked to think about these contributions socially and mathematically. Teacher candidates might respond to this prompt by talking about the interaction of the teacher and student, the interaction of the teacher and content, and the interaction of the student and content. Additionally, teacher candidates were asked to make sense of the interplay of the teacher's contribution and students' contribution within a mathematical context. Teacher candidates might respond to this prompt by talking about the interaction of the teacher, student, and content. The responses to these prompts directly tied to the interaction of the instructional features. However, it was interesting that teacher candidates most frequently attended to the interaction of the teacher, student, and content, which was more complex than other interactions were.

The complexity of teacher candidates' noticing might be related to ambitious teaching. When teacher candidates noticed the interaction of the teacher, student, and content, their narrative detailed how their instruction connected to the students and the mathematics. Teacher candidates could see how the teacher in the video clip attended to students' authentic mathematics. They saw themselves as using particular high leverage practices, such as using discourse strategies to elicit and respond to students' ideas in order to advance students' learning. All of these actions occurred in the context of solving mathematical problems. Additionally, this complex noticing might be important for teacher candidates to adjust teaching (Lampert et al., 2011). As teacher candidates noticed the interactions of the teacher, student, and content, they

could see the teacher's action in relation to students' action when working with mathematical problems. Based on these relationships, I could hypothesize alternative strategies that affected students' mathematical learning differently (Santagata & Angelici, 2010). This directly tied to teaching adjustment, which is a goal of ambitious teaching.

The increase in the complexity of teacher candidates' noticing in my study was different from the findings of prior studies. First, there was no prior study focusing on the interaction of instructional features. Even though some prior studies, such as a study by Jacobs et al. (2010), paid attention to the noticing of instructional features, this study focused on an individual instructional feature. Jacobs and colleagues did not pay attention to the interactions of instructional features. Thus, the findings of my study suggested that with the appropriate prompts provided, teacher candidates could notice the interaction of instructional features rather than an individual instructional feature.

In addition, the study by Jacobs and colleagues reported that teacher candidates could attend to an individual instructional feature. Their study did not report the increase of teacher candidates' attending to an instructional feature. In contrast, the results of my study revealed that teacher candidates increased their attention to the interaction of the teacher, student, and content across reflections. This suggests that the complexity of teacher candidates' noticing increased over time.

Teacher candidates' complex noticing on topic, presence of evidence, and instructional features were related to the stances that teacher candidates took as they analyzed teaching. However, the results in Chapter Four and Chapter Five revealed that teacher candidates did not frequently talk about teaching alternatives when they were learning to notice. I discuss this finding in the next sub-section.

Teacher candidates' complex interpretations of teaching rarely attended to offering alternatives. Based on the syntheses of results, I found that teacher candidates did not frequently offer teaching alternatives when they analyzed teaching. In less than a quarter of the idea units, teacher candidates talked about teaching strategies different from those in the video clips. Additionally, the coefficient of variation values showed that teacher candidates did not consistently offer teaching alternatives across the reflections.

However, teacher candidates' offering teaching alternatives seemed to be positively related to teacher candidates' complex noticing. Based on the syntheses of results, I found that teacher candidates increased their attention to the interaction of the teacher, student, and content

as they offered teaching alternatives from reflections one to three. In addition, the analyses of the inner-quartile range showed that teacher candidates' offering teaching alternatives increased across reflections. However, teacher candidates less frequently attended to offering teaching alternatives than they did other stances. The means of the percentages of the idea units with teaching alternatives were 20% in all reflections. Furthermore, the variation of offering alternatives also increased across reflections. This suggests that even though the offering teaching alternative stance was positively related to teacher candidates' attention to the interaction of the teacher, student, and content, as the complexity of classroom teaching, they rarely attended to offering alternatives.

The results, which show that teacher candidates were less likely to offer teaching alternatives, may be related to the lack of prompts guiding them to propose teaching differently based on the analysis of video clips. Teacher candidates might have offered teaching alternatives when they talked about their teaching difficulties and proposed teaching strategies for solving the difficulties. In the idea units with teaching alternatives, teacher candidates might talk about the additional use of discourse strategies to orient students to one another and/or to the discipline or to elicit and respond to students' thinking within a mathematical context. Teacher candidates might include expected responses from students in their alternatives. These situations showed the possibility that teacher candidates paid attention to the interaction of the teacher, student, and content when they offered teaching alternatives. However, teacher candidates were not explicitly supported to think about teaching alternatives as they engaged in reflections of classroom teaching. Thus, their proposition of teaching alternatives was low. This suggests the necessity of prompts in guiding teacher candidates' to offer teaching alternatives.

Suggestion about the necessity of prompts in guiding teacher candidates to offer teaching alternatives was similar to the suggestions from prior studies. For instance, a study by Santagata and Angelici (2010) explained that the use of prompts was necessary in guiding teacher candidates to offer teaching alternatives. With the use of reflection questions in their study, teacher candidates showed quantitative and qualitative improvement in offering teaching alternatives. Additionally, the use of prompts to enhance teacher candidates' thinking about teaching differently from the teaching in video clips was important to students' learning to notice. Mason (2011) explained that it is necessary for teachers to have a set of teaching alternatives in mind. With the set of teaching, they are able to "act freshly" as they adjust teaching based on

what students understand and/or do not understand. Thus, it seems necessary to include the prompts for offering alternatives in future studies.

Summary

In summary, I found that teacher candidates in my study consistently interpreted teaching evidence. The finding was related to how they were continuously guided to reflect on their teaching. The continuous use of reflection questions as prompts guiding teacher candidates to focus on the topic of teacher's instruction, to use evidence to support their analyses of teaching, and to interpret teaching was effective. This finding supported the importance of using prompts to guide teacher candidates' noticing as they developed their noticing abilities.

Additionally, I found that teacher candidates in my study increased the complexity of their noticing over time. This finding was related to how they were continuously guided to interpret the interplay of the teacher's contribution and students' contribution within a mathematical context. Besides supporting the importance of using prompts to guide teacher candidates' noticing, this finding plays an important role in enhancing teacher candidates to teach ambitiously.

Although teacher candidates increased the complexity of noticing, their complex interpretation of classroom teaching attended more to offering teaching alternatives. When teacher candidates made judgments on the quality of their teaching, teacher candidates might propose teaching strategies different from the teaching in the video clips with the interaction of the teacher, student, and content. However, their proposition of teaching alternatives was low compared with the taking of other stances. The prompts might be necessary for guiding teacher candidates to offer teaching alternatives.

Based on the results in Chapter Four and Chapter Five and the discussion in this chapter, I discussed the implications and limitations of my study in the next chapter.

Chapter 7
Implications, Limitations, and Conclusion

This last chapter discusses the implications and limitations of my study on teacher candidates' noticing from analyses of their reflections assigned within two consecutive mathematics methods courses within a teacher education program supporting ambitious mathematics teaching. This quantitative study was conducted with the purpose of investigating what teacher candidates noticed about their teaching as they were provided support and opportunities to develop skills with ambitious instruction during a mathematics teacher preparation program. Based on the assumption that teacher candidates should learn to notice instructional features, consisting of the teacher, student, and content, and the interaction of these instructional features, this study focused on how teacher candidates noticed the interaction of the teacher, student, and content within the context of mathematics classroom instruction. The research questions driving my study were:

1. What did teacher candidates most frequently notice when they analyzed their teaching?
2. What was the pattern of teacher candidates' noticing within and across the four written reflections?
3. How were the stances that teacher candidates took as they analyzed their teaching related to other noticing dimensions?

To address these research questions, my study was conducted with 11 teacher candidates who were in a mathematics teacher preparation program. Teacher candidates learned to notice the interaction of instructional features within two mathematics methods courses designed to support ambitious teaching across two academic terms. Teacher candidates were provided opportunities to learn to notice the interaction of instructional features by watching videotapes of their classroom teaching and engaging in reflection of the teaching in the videotapes. Their reflections on classroom teaching were structured by prompts guiding their topics of focus, use of evidence, attention to instructional features, and analyses of teaching.

From the analyses of written reflections, I found that teacher candidates frequently and consistently interpreted instruction by using evidence to support their interpretations. Teacher candidates increased the complexity of their noticing by paying more attention to the interaction of the teacher, student, and content over time. Their interpretations of significant moments were

positively related to the noticing of the topic of instruction, the use of evidence, and the attention to the interaction of the teacher, student, and content. Also, teacher candidates' offering teaching alternatives was positively correlated with their attention to the interaction of the teacher, student, and content. However, teacher candidates in my study infrequently offered teaching alternatives.

These findings contribute to the improvement of teacher preparation programs and further studies on mathematics teacher noticing. These implications are discussed in this chapter. Then, I discuss the limitations of the study. The conclusion of the study is described at the end of this chapter.

Implications for the Improvement of Mathematics Teacher Education Programs

In this section, I discuss the implications of my study for the improvement of teacher education programs. The discussion of these implications suggests the need for further studies. First of all, I found the use of videotapes of IA enactments as an effective approach to support teacher candidates' learning to notice the interaction of instructional features. As described in Chapter Three, teacher candidates in my study learned to notice in the context of an ambitious mathematics teacher education program. They rehearsed teaching based on IAs designed around high leverage teaching practices necessary for ambitious teaching. The use of IAs supported teacher candidates in teaching ambitiously. For instance, teaching based on IAs created opportunities for teacher candidates to elicit and respond to students' mathematical thinking by using a variety of strategies. Because IAs were designed to specify interactions between the teacher and students around mathematical content (Kazemi, Franke, & Lampert, 2009), it was possible that the enactment of these IAs consisted of the interactions of instructional features.

Because my study used videotapes of IA enactments as an approach supporting teacher candidates to learn to notice, it was more possible that teacher candidates were provided opportunities to see the interaction of the teacher, student, and content. Even though not all videotapes of classroom teaching had significant moments that teacher candidates should notice (Santagata, Zannoni, & Stigler, 2007), videotapes of IA enactments in my study might be different. The videotapes used in my study were recorded from the IA enactments, which consisted of the interaction between the teacher and students within a mathematical context. Thus, it was more likely that these videotapes contained moments showing the interaction of instructional features. In other words, watching the videotapes of IA enactments provides

evidence for teacher candidates to practice marking the moments with the interaction of instructional features. The existence of the interaction of instructional features in the videotapes of IA enactments was supported by the results of my study that teacher candidates could attend to the interactions of instructional features in all reflections. Thus, the use of videotapes of IA enactments in my study contributed to a possible approach to supporting teacher candidates' learning to notice.

Additionally, from the results in Chapter Four and Chapter Five and the discussion in Chapter Six, I found the use of prompts to be an effective tool for supporting teacher candidates' noticing. As discussed in Chapter Six, reflection prompts played an important role in guiding teacher candidates to frequently and consistently interpret the evidence of teaching. The use of prompts was also effective in guiding teacher candidates to frequently and increasingly notice the complexity of classroom teaching, which included the interaction of the teacher, student, and content.

In my study, teacher candidates were guided to focus on the topic of the teacher's instruction as they: selected moments from the video clips showing their enactment of high leverage teaching practices, connected the moments to specific high leverage teaching practices, interpreted the teacher's instruction, and talked about teaching growth and difficulties. They were guided to talk about the topic of students' participation as they interpreted students' contribution. Teacher candidates were also guided to use evidence in their analyses of teaching through a prompt asking them to connect the moments in video clips to high leverage teaching practices. They were guided to interpret teaching through a prompt asking them to talk about how they made sense of the teacher's contribution and students' contribution. Additionally, teacher candidates were guided to attend to the interaction of the teacher, student, and content through a prompt asking them to make sense of the interplay between the teacher's contribution and students' contribution within mathematical and social contexts. In these ways, the use of prompts in my study contributed to a possible tool for promoting teacher candidates to interpret the teacher's instruction by using evidence to support the interpretation.

Even though the results of my study revealed that mathematical content was not a topic of focus in the narrative, this evidence did not show the failure in using prompts to guide teacher candidates to think about the topic of mathematical content. In contrast, teacher candidates' talk about mathematical content was integrated into other instructional features as

they talked about the interaction of the teacher, student, and content. Importantly, teacher candidates increased the talk attending to the interaction of the teacher, student, and content over time. This evidence showed an increase of the integration of mathematical content into other instructional features. This finding suggests how the use of prompts could effectively promote the integration of mathematical content into other instructional features. Thus, the use of prompts in my study also contributed to a possible tool for supporting teacher candidates in integrating various instructional features.

The evidence in my study also shows the need for additional prompts to guide teacher candidates' noticing, especially the prompts guiding teacher candidates to offer teaching alternatives. As described in Chapter Five, teacher candidates' proposition of teaching alternatives was shown to be supportive of teacher candidates' learning to notice important contributions in the classroom. Teacher candidates' offering teaching alternatives was positively related to their focus on the topics of the teacher's instruction, use of evidence, and attention to the interaction of the teacher, student, and content. Even though teacher candidates might have offered teaching alternatives when they evaluated teaching, their offering of teaching alternatives was not frequent and consistent. As discussed in Chapter Six, this situation might be related to the lack of a prompt that explicitly guided teacher candidates to offer teaching alternatives. Thus, the prompts for offering teaching alternatives might be necessary in order to enhance teacher candidates to attend to teaching alternatives.

In summary, the use of videotapes of IA enactments was an effective approach for supporting teacher candidates' learning to notice the interaction of instructional features. The videotapes of IA enactments provided evidence for teacher candidates to see and mark the significant moments of the interactions of the teacher, student, and content. With the use of prompts guiding their noticing, teacher candidates could interpret teaching evidence and integrate various instructional features in their interpretations. However, the prompts guiding teacher candidates to offer teaching alternatives should be included in order to support teacher candidates to think about teaching differently from the teaching in the videotapes.

These contributions and suggestions were necessary for the improvement of a mathematics teacher preparation program in enhancing teacher candidates' noticing. The common research tools could be implemented to enhance teacher candidates' learning to notice during their study in teacher preparation programs. The use of videotapes of IA enactments could be implemented as an effective tool for providing evidence of the interactions of the

teacher, student, and content within mathematics classroom teaching. The use of reflection prompts could be implemented as an effective tool guiding teacher candidates' interpretations of teaching evidence and the integration of instructional features in the interpretations. In addition, the additional prompts on offering teaching alternatives could be included.

Implications for Future Studies

The purpose of this study was to explore what teacher candidates noticed about their teaching when they were studying in a teacher preparation program. By providing opportunities to notice the interaction of instructional features and guiding the noticing by reflection prompts, teacher candidates focused on the topic of the teacher's instruction, used specific evidence as they talked about teaching, paid attention to the interaction of instructional features, and interpreted teaching. In this section, I discuss two implications of this study for future studies.

First, a longitudinal quantitative study should be conducted. As suggested, videotapes of IA enactments and reflection prompts were effective in guiding teacher candidates to notice the interaction of instructional features. However, teacher candidates' noticing may change over time. The noticing patterns and relationships of stance and instructional features presented in Chapter Four and Chapter Five may change if teacher candidates spend more time learning to notice with these tools. Thus, a future longitudinal study could be conducted to explore if there is any change of teacher candidates' noticing patterns over time.

However, with the limitation of quantitative analyses, my study and the suggested longitudinal quantitative study could not provide insight on what teacher candidates noticed. Thus, future qualitative studies should be conducted. The results of quantitative analyses in my study showed the existence of particular topics, the presence of evidence, instructional features, and stances. However, these results did not show the existence of these noticing dimensions in detail. For instance, as teacher candidates talked about high leverage teaching practices, the quantitative analysis could only identify that teacher candidates focused on the topic of the teacher's instruction in these particular idea units. By employing qualitative analyses, results from future qualitative studies may be able to identify how teacher candidates talk about specific high leverage teaching practices. In addition, a subset of teacher candidates could be selected as a focus group to obtain more details about how they notice the interactions of instructional features.

Limitations

This quantitative study of teacher candidate noticing across two terms of mathematics methods had limitations. The first limitation was the length of the study. My study was conducted with teacher candidates within five months. Results of teacher candidates' noticing in Chapter Four and Chapter Five showed what teacher candidates notice within five months. Because there was no prior study suggesting an appropriate length of time for developing noticing ability, there was no evidence confirming that teacher candidates already developed their ability to notice during the program. Even though the results of my study revealed the consistency of teacher candidates' topics of focus, use of evidence, interpretations of teaching, and understanding of teaching complexity, these evidences were not sufficient to conclude whether or not teacher candidates already developed noticing. Also, these evidences were insufficient to refer to the consistency in noticing of the participating teacher candidates in the future.

Even though some researchers suggested that noticing ability was related to teaching ability, my study focused only on what teacher candidates noticed during the program. My study did not pay attention to how teacher candidates taught in the classroom in their student rehearsal. Thus, the results of my study could not link to their teaching abilities both during the program and in the future. To link teacher candidates' noticing and teaching abilities, future studies that compare these abilities might be conducted.

The last limitation was the size of the sample of participants and the selection of participants. Because of the uniqueness of the methodology used in my study, purposive sampling was used to select the participants of the study. My study was conducted with a small number of participants who were all teacher candidates enrolled in a teacher preparation program in a particular academic year. These facts might affect the generalization of the study.

Conclusion

Developing teacher noticing is suggested as a way to prepare teacher candidates to effectively teach mathematics in the context of mathematics education reform (van Es & Sherin, 2008). Besides learning to notice teaching, prior research on teaching suggests that teacher candidates should learn to notice various attributes of classroom instruction, including instructional features (teacher, student, and content) and the interaction of these features. My

study intended to provide information about what teacher candidates noticed when the opportunities to notice the instructional features and the interactions of these features were provided.

Teacher candidates in my study learned to notice by watching videotapes of their student teaching based on IAs that specified the interactions of instructional features. When teacher candidates engaged in reflection on teaching, they were prompted by reflection questions that guided them to focus on various important topics, to use evidence to support their classroom analysis, to pay attention to the interactions of instructional features, and to take various stances.

Results from the analyses of written reflections revealed that teacher candidates frequently focused on the topic of the teacher's instruction, used evidence in their talk about teaching, paid attention to the interaction of instructional features, and interpreted teaching. When teacher candidates interpreted teaching, they were likely to talk about instruction, include evidence in their talk, and pay attention to the interactions of the teacher, student, and content. Based on the syntheses of these results, I found that teacher candidates frequently and consistently interpreted their teaching evidence. The complexity of their noticing increased over time. However, their complex interpretations of teaching infrequently attended to offering teaching alternatives. These findings were possibly related to how teacher candidates were prompted to reflect on teaching by a set of reflection questions that guided their noticing.

In summary, the results of my study show the impacts of these provided opportunities on teacher candidates' noticing during the time the study was conducted. When teacher candidates learned to notice the instructional features by reflecting on their videotapes of student rehearsal within an ambitious teaching context, it seemed that teacher candidates had a particular noticing of the topic, the presence of evidence, the interaction of instructional features, and stance.

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APPENDICES

Appendix A

Principles of High Quality Teaching and Principles of Learning to Teach
(Adapted from Kazemi, Franke, & Lampert, 2009; Lampert et al., 2013; LTP Project)

Principles of High Quality Teaching

1. Students are sense makers, individuals, and members of families and communities.
2. Students need opportunities to:
    - engage with authentic mathematics,
    - be users and authors of mathematics,
    - reflect and make productive generalizations about their learning.
3. Teachers design and enact equitable instruction that:
    - represents the discipline authentically,
    - focuses on key learning goals,
    - supports connections between school and community,
    - builds on evidence of student reasoning,
    - honors the requirements of schools and the diverse communities in which students live,
    - engages students as mathematical knowers and doers.

Principles of Learning to Teach

1. Teaching is intellectual work requiring specialized knowledge of content and pedagogy.
2. Learning to teach requires repeated opportunities to practice and the development of a shared language of practice.
3. There is a value in making teaching public.
4. Teachers' learning experiences and identities shape what they know and do and should be open to examination and reflection.
5. Teaching is a complex activity that must be learned and continually examined.

Appendix B

Rehearsal Reflection Questions (Elliott & Aaron, 2014)

Practice Focus of IA: Teacher candidates have an opportunity to work on *eliciting and being responsive to students reasoning* and *constructing and organizing a public record* using discourse moves to support students' reasoning and make it available to the whole class for consideration. For consideration in doing this work think about how are students' ideas elicited, how are students' ideas responded to, and who is doing the mathematical reasoning? What challenges does this IA present when thinking about how is the mathematical territory unfolding that moves teaching and learning toward the student objective and the unfolding storyline (the unfolding of the mathematical point of the lesson intertwined with students' mathematical reasoning) advanced?

Part A -- Select three clips, each aligned to one of the three foci listed above. For each clip please complete the following items:

1) Transcribe the clip. You can format the transcript by contribution starting with the speaker's initials.
2) Describe, using evidence/reference to specific talk, moves, student ideas, etc, how you see the clip connected to selected focus.
3) What sense do you make of the student(s) participation/contributions? Be sure to think about this mathematically and socially as appropriate.
4) What sense do you make of the interplay between your contributions and the students contributions for advancing students' learning?

Part B -- Where do you see growth in your practice evidenced?

1) In a narrative compare your work in student teaching, rehearsals at OSU, and your IA enactment with high school students and discuss where you see evidence of growth in your instructional practice.
2) Describe your growth in relation to our teaching practices, ambitious teaching, or other important areas of teaching/learning. Be selective and detailed. You don't have to address everything

Part C -- Elaborate on the challenge of teaching students ambitiously.

1) What seems particularly difficult for you? What example illustrates this challenge for you?
2) What are the next steps in your learning that attend to your growth with the practices and other ideas linked to ambitious teaching?
3) What resources do you need to make progress and how do you imagine carrying out these steps in your student teaching placement?

Appendix C

Frequencies and Percentages of Idea Units Associated with Different Topics in Each Reflection

	IA				
Topic	1	2	3	4	Total
Teacher's instruction	126	110	77	108	421
	(68.85)	(73.83)	(71.30)	(76.60)	(72.09)
Students' Participation	57	38	30	33	158
	(30.98)	(25.50)	(27.77)	(23.08)	(27.05)
Mathematical Content	1	1	1	2	5
	(0.54)	(0.67)	(0.93)	(1.40)	(0.86)
Total	184	149	108	143	584
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns appear in parentheses below frequencies

Appendix D

Frequencies and Percentages of Idea Units Associated with Different Topics in Each Reflection by Each Teacher Candidates

		Teacher Candidate											
IA	Topic	TC01	TC02	TC03	TC04	TC05	TC06	TC07	TC08	TC09	TC10	TC11	Total
1	TI	11	16	14	14	8	10	11	9	10	11	12	126
		(64.71)	(72.73)	(82.35)	(66.67)	(57.14)	(66.67)	(64.71)	(56.25)	(66.67)	(73.33)	(80.00)	(68.48)
	SP	6	5	3	7	6	5	6	7	5	4	3	57
		(35.29)	(22.73)	(17.65)	(33.33)	(42.86)	(33.33)	(35.29)	(43.75)	(33.33)	(26.67)	(20.00)	(30.98)
	MC	0	1	0	0	0	0	0	0	0	0	0	1
		(0.00)	(4.55)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.54)
2	TI	13	14	9	9	12	9	10	8	8	10	8	110
		(81.25)	(77.78)	(75.00)	(69.23)	(60.00)	(75.00)	(83.33)	(80.00)	(72.73)	(83.33)	(57.14)	(73.83)
	SP	3	4	3	3	8	3	2	2	3	2	5	38
		(18.75)	(22.22)	(25.00)	(23.08)	(40.00)	(25.00)	(17.67)	(20.00)	(27.27)	(16.67)	(42.86)	(25.50)
	MC	0	0	0	1	0	0	0	0	0	0	0	1
		(0.00)	(0.00)	(0.00)	(7.69)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.67)
3	TI	4	8	13	6	7	6	7	9	6	8	3	77
		(57.14)	(80.00)	(81.25)	(60.00)	(63.64)	(66.67)	(70.00)	(81.82)	(66.67)	(88.89)	(50.00)	(71.30)
	SP	3	2	3	4	4	3	3	2	2	1	3	30
		(42.86)	(20.00)	(18.75)	(40.00)	(36.36)	(33.33)	(30.00)	(18.18)	(22.22)	(11.11)	(50.00)	(27.77)
	MC	0	0	0	0	0	0	0	0	1	0	0	1
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(11.11)	(0.00)	(0.00)	(0.93)
4	TI	7	14	12	15	9	4	9	6	11	14	7	108
		(63.64)	(77.78)	(80.00)	(88.24)	(52.94)	(66.67)	(81.82)	(54.55)	(84.62)	(93.33)	(77.78)	(76.60)
	SP	2	4	3	2	8	2	2	5	2	1	2	33
		(18.18)	(22.22)	(20.00)	(11.76)	(47.06)	(33.33)	(18.18)	(45.45)	(15.38)	(6.67)	(22.22)	(23.08)
	MC	2	0	0	0	0	0	0	0	0	0	0	2
		(18.18)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(1.40)
Total	TI	35	52	48	44	36	29	37	32	35	43	30	421
		(67.63)	(76.47)	(80.00)	(72.13)	(58.06)	(69.05)	(74.00)	(66.67)	(72.92)	(84.31)	(69.77)	(72.09)
	SP	14	15	12	16	26	13	13	16	12	8	13	158
		(27.45)	(22.06)	(20.00)	(26.23)	(41.94)	(30.95)	(26.00)	(33.33)	(25.00)	(15.69)	(30.23)	(27.05)
	MC	2	1	0	1	0	0	0	0	1	0	0	584
		(3.92)	(1.47)	(0.00)	(1.64)	(0.00)	(0.00)	(0.00)	(0.00)	(2.08)	(0.00)	(0.00)	(100.00)
	Total	51	68	60	61	62	42	50	48	48	51	43	584
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within teacher candidates appear in parentheses below frequencies

Appendix E

Frequencies and Percentages of Idea Units Associated with the Presences of Evidence in Each Reflection

Presence of Evidence	IA				
	1	2	3	4	Total
Presented evidence	129	111	91	98	429
	(70.11)	(74.50)	(84.26)	(68.53)	(73.46)
No evidence	55	38	17	45	155
	(29.89)	(25.50)	(15.74)	(31.47)	(26.54)
Total	184	149	108	143	584
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns appear in parentheses below frequencies

Appendix F

Frequencies and Percentages of Idea Units Associated with the Presences of Evidence in Each Reflection by Each Teacher Candidate

IA	Presence of Evidence	Teacher Candidate											
		TC01	TC02	TC03	TC04	TC05	TC06	TC07	TC08	TC09	TC10	TC11	Total
1	Presented	11	16	11	14	9	12	15	15	11	8	7	129
		(64.71)	(72.73)	(64.71)	(66.67)	(64.29)	(80.00)	(88.24)	(93.75)	(73.33)	(53.33)	(46.67)	(70.11)
	No	6	6	6	7	5	3	2	1	4	7	8	55
		(35.29)	(27.27)	(35.29)	(33.33)	(35.71)	(20.00)	(11.76)	(6.25)	(26.67)	(46.67)	(53.33)	(29.89)
2	Presented	10	13	8	10	14	8	9	9	7	11	12	111
		(62.50)	(72.22)	(66.67)	(76.92)	(70.00)	(66.67)	(75.00)	(90.00)	(63.64)	(91.67)	(92.31)	(74.50)
	No	6	5	4	3	6	4	3	1	4	1	1	38
		(37.50)	(27.78)	(33.33)	(23.08)	(30.00)	(33.33)	(25.00)	(10.00)	(36.36)	(8.33)	(7.69)	(25.50)
3	Presented	6	8	14	8	8	7	9	10	8	8	5	91
		(85.71)	(80.00)	(87.50)	(80.00)	(72.73)	(77.78)	(90.00)	(90.91)	(88.89)	(88.89)	(83.33)	(84.26)
	No	1	2	2	2	3	2	1	1	1	1	1	17
		(14.29)	(20.00)	(12.50)	(20.00)	(27.27)	(22.22)	(10.00)	(9.09)	(11.11)	(11.11)	(16.67)	(15.74)
4	Presented	8	11	11	8	13	4	8	8	9	10	8	98
		(72.73)	(61.11)	(73.33)	(47.06)	(76.47)	(66.67)	(72.73)	(72.73)	(69.23)	(66.67)	(88.89)	(68.53)
	No	3	7	4	9	4	2	3	3	4	5	1	45
		(27.27)	(38.89)	(26.67)	(52.94)	(23.53)	(33.33)	(27.27)	(27.27)	(30.77)	(33.33)	(11.11)	(31.47)
Total	Presented	35	48	44	40	44	31	41	42	35	37	32	429
		(68.63)	(70.59)	(73.33)	(65.57)	(70.97)	(73.81)	(82.00)	(87.50)	(72.92)	(72.55)	(74.42)	(73.46)
	No	16	20	16	21	18	11	8	6	13	14	11	155
		(31.37)	(29.41)	(26.67)	(34.43)	(29.03)	(26.19)	(18.00)	(12.50)	(27.08)	(27.45)	(25.58)	(26.54)
	Total	51	68	60	61	62	42	50	48	48	51	43	584
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within teacher candidates appear in parentheses below frequencies

Appendix G

Frequencies and Percentages of Idea Units Associated with Different Instructional Features in Each Reflection

	IA				
Instructional Feature	1	2	3	4	Total
Teacher	66	49	28	53	196
	(35.87)	(32.89)	(25.93)	(37.06)	(33.56)
Student	8	7	1	2	18
	(4.35)	(4.70)	(0.93)	(1.40)	(3.08)
Teacher-Student	59	32	22	30	143
	(32.07)	(21.48)	(20.37)	(20.98)	(24.49)
Teacher-Content	1	4	4	4	13
	(0.54)	(2.68)	(3.70)	(2.80)	(2.23)
Student-Content	7	10	8	7	32
	(3.83)	(6.90)	(7.69)	(5.04)	(5.48)
Teacher-Student-Content	43	47	45	47	182
	(23.50)	(32.41)	(43.27)	(32.87)	(31.87)
Total	183	145	104	139	571
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns appear in parentheses below frequencies

Appendix H

Frequencies and Percentages of Idea Units Associated with Different Instructional Features in Each Reflection by Each Teacher Candidate

IA	Instructional Feature	Teacher Candidate											
		TC01	TC02	TC03	TC04	TC05	TC06	TC07	TC08	TC09	TC10	TC11	Total
1	T	7	7	8	11	5	3	5	3	4	5	8	66
		(41.18)	(31.82)	(47.06)	(52.38)	(35.71)	(20.00)	(29.41)	(18.75)	(26.67)	(33.33)	(53.33)	(35.87)
	TS	6	7	9	9	4	5	7	3	4	1	4	59
		(35.29)	(31.82)	(52.94)	(42.86)	(28.57)	(33.33)	(41.18)	(18.75)	(26.67)	(6.67)	(26.67)	(32.07)
	TSC	3	7	0	1	1	3	5	10	5	5	3	43
		(17.65)	(31.82)	(0.00)	(4.76)	(7.14)	(20.00)	(29.41)	(62.50)	(33.33)	(33.33)	(20.00)	(23.37)
2	T	7	6	3	5	8	5	6	1	4	2	2	49
		(43.75)	(33.33)	(25.00)	(38.46)	(40.00)	(41.67)	(50.00)	(10.00)	(36.36)	(16.67)	(15.38)	(32.89)
	TS	0	2	4	3	7	1	2	3	2	3	5	32
		(0.00)	(11.11)	(33.33)	(23.08)	(35.00)	(8.33)	(16.67)	(30.00)	(18.18)	(25.00)	(38.46)	(21.48)
	TSC	6	8	3	5	1	6	2	3	2	5	6	47
		(37.50)	(44.44)	(25.00)	(38.46)	(5.00)	(50.00)	(16.67)	(30.00)	(18.18)	(41.67)	(46.15)	(31.54)
3	T	1	2	4	2	3	4	2	2	3	4	1	28
		(14.29)	(20.00)	(25.00)	(20.00)	(27.27)	(44.44)	(20.00)	(18.18)	(33.33)	(44.44)	(16.67)	(25.93)
	TS	0	3	4	0	4	4	3	1	1	2	0	22
		(0.00)	(30.00)	(25.00)	(0.00)	(36.36)	(44.44)	(30.00)	(9.09)	(11.11)	(22.22)	(0.00)	(20.37)
	TSC	5	5	7	7	3	0	2	6	3	3	4	45
		(71.43)	(50.00)	(43.75)	(70.00)	(27.27)	(0.00)	(20.00)	(54.55)	(33.33)	(33.33)	(66.67)	(41.67)
4	T	3	6	6	11	4	2	3	3	5	6	4	53
		(27.27)	(33.33)	(40.00)	(64.71)	(23.53)	(33.33)	(27.27)	(27.27)	(38.46)	(40.00)	(44.44)	(37.06)
	TS	0	4	0	3	3	1	3	4	6	6	0	30
		(0.00)	(22.22)	(0.00)	(17.65)	(17.65)	(16.67)	(27.27)	(36.36)	(46.15)	(40.00)	(0.00)	(20.98)
	TSC	6	7	8	1	7	2	4	3	1	3	5	47
		(54.55)	(38.89)	(53.33)	(5.88)	(41.18)	(33.33)	(36.36)	(27.27)	(7.79)	(20.00)	(66.56)	(32.87)
Total	T	18	21	21	29	20	14	16	9	16	17	15	196
		(35.29)	(30.88)	(35.00)	(47.54)	(32.26)	(33.33)	(32.00)	(18.75)	(33.33)	(33.33)	(34.88)	(33.56)
	TS	6	16	17	15	18	11	15	11	13	12	9	143
		(11.76)	(23.53)	(28.33)	(24.59)	(29.03)	(26.19)	(30.00)	(22.92)	(27.08)	(23.53)	(20.93)	(24.49)
	TSC	20	27	18	14	12	11	13	22	11	16	18	182
		(39.22)	(39.71)	(30.00)	(22.95)	(19.35)	(26.19)	(26.00)	(45.83)	(22.92)	(31.37)	(41.86)	(31.16)
	Total	51	68	60	61	61	42	50	48	48	51	43	584
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within teacher candidates appear in parentheses below frequencies

Appendix I

Frequencies and Percentages of Idea Units Associated with Different Stances in Each Reflection

	IA				
Main Stance	1	2	3	4	Total
Interpret	103	93	82	82	360
	(55.98)	(62.42)	(75.93)	(57.34)	(61.64)
Evaluate	59	40	25	37	161
	(32.07)	(26.85)	(23.15)	(25.87)	(27.57)
Describe	51	33	9	32	125
	(27.72)	(22.15)	(8.33)	(22.38)	(21.40)
Offer personal perspective	47	38	15	20	120
	(25.54)	(25.50)	(13.89)	(13.99)	(20.55)
Offer teaching alternative	23	21	20	10	74
	(12.50)	(14.09)	(18.52)	(6.99)	(12.67)

Percentages within columns appear in parentheses below frequencies

Appendix J

Frequencies and Percentages of Idea Units Associated with Different Stances in Each Reflection by Each Teacher Candidates

		Teacher Candidate											
IA	Stance	TC01	TC02	TC03	TC04	TC05	TC06	TC07	TC08	TC09	TC10	TC11	Total
1	Interpret	11	12	8	14	8	8	8	13	8	6	7	103
		(44.71)	(54.55)	(47.06)	(66.67)	(57.14)	(53.33)	(47.06)	(81.25)	(53.33)	(40.00)	(46.67)	(55.98)
	Evaluate	2	7	6	8	3	6	8	4	7	6	2	59
		(11.76)	(31.82)	(35.29)	(38.10)	(21.43)	(40.00)	(47.06)	(25.00)	(46.67)	(40.00)	(13.33)	(32.07)
	Describe	4	2	4	4	3	6	8	3	4	6	7	51
		(25.53)	(9.09)	(23.53)	(19.05)	(21.43)	(40.00)	(47.06)	(18.75)	(25.67)	(40.00)	(46.67)	(27.72)
	Perspective	3	10	8	6	4	2	1	1	2	3	7	47
		(17.65)	(44.45)	(47.06)	(28.57)	(28.57)	(13.33)	(5.88)	(6.25)	(13.33)	(20.00)	(46.47)	(25.54)
	Alternative	4	4	2	0	1	1	0	3	4	2	2	23
		(23.53)	(18.18)	(11.76)	(0.00)	(7.14)	(6.47)	(0.00)	(18.75)	(26.67)	(13.33)	(13.33)	(12.50)
2	Interpret	9	10	8	6	12	8	5	8	7	10	10	93
		(56.25)	(55.56)	(66.67)	(46.15)	(60.00)	(66.67)	(41.67)	(80.00)	(63.64)	(83.33)	(76.92)	(62.42)
	Evaluate	3	6	2	7	3	3	4	3	2	5	2	40
		(18.75)	(33.33)	(16.67)	(53.85)	(15.00)	(25.00)	(33.33)	(30.00)	(18.18)	(41.67)	(15.38)	(26.85)
	Describe	5	6	3	6	6	2	3	0	2	0	0	33
		(31.25)	(33.33)	(25.00)	(46.15)	(30.00)	(16.67)	(25.00)	(0.00)	(18.18)	(0.00)	(0.00)	(22.15)
	Perspective	3	4	3	4	8	4	3	1	2	2	4	38
		(18.75)	(22.22)	(25.00)	(30.77)	(40.00)	(33.33)	(25.00)	(10.00)	(18.18)	(16.67)	(30.77)	(25.50)
	Alternative	3	5	1	1	0	0	1	2	3	1	4	21
		(18.75)	(27.78)	(8.33)	(7.69)	(0.00)	(0.00)	(8.33)	(20.00)	(27.27)	(8.33)	(30.77)	(14.09)

Percentages within teacher candidates appear in parentheses below frequencies

Appendix J (Continued)

		Teacher Candidate											
IA	Stance	TC01	TC02	TC03	TC04	TC05	TC06	TC07	TC08	TC09	TC10	TC11	Total
3	Interpret	4	8	12	8	9	5	9	9	7	7	4	82
		(57.14)	(80.00)	(75.00)	(80.00)	(81.82)	(55.56)	(90.00)	(81.82)	(77.78)	(77.78)	(66.67)	(75.93)
	Evaluate	2	1	2	3	0	3	3	6	2	2	1	25
		(28.57)	(10.00)	(12.50)	(30.00)	(0.00)	(33.33)	(30.00)	(54.55)	(22.22)	(22.22)	(16.67)	(23.15)
	Describe	1	0	1	2	1	2	0	1	0	1	0	9
		(14.29)	(0.00)	(6.25)	(20.00)	(9.09)	(22.22)	(0.00)	(9.09)	(0.00)	(11.11)	(0.00)	(8.33)
	Perspective	1	2	2	1	2	1	1	1	1	2	1	15
		(14.29)	(20.00)	(12.50)	(10.00)	(18.18)	(11.11)	(10.00)	(9.09)	(11.11)	(22.22)	(16.67)	(13.89)
	Alternative	2	4	4	2	0	2	0	3	0	2	1	20
		(28.57)	(40.00)	(25.00)	(20.00)	(0.00)	(22.22)	(0.00)	(27.27)	(0.00)	(22.22)	(16.67)	(18.52)
4	Interpret	6	11	10	6	13	4	7	5	7	8	5	82
		(54.55)	(61.11)	(66.67)	(35.29)	(76.47)	(66.67)	(63.64)	(45.45)	(53.87)	(53.33)	(55.56)	(57.34)
	Evaluate	4	4	2	7	1	1	4	2	3	7	2	37
		(36.36)	(22.22)	(13.43)	(41.18)	(5.88)	(16.67)	(36.36)	(18.18)	(23.08)	(46.67)	(22.22)	(25.87)
	Describe	2	3	1	8	3	1	2	5	2	1	4	32
		(18.18)	(16.67)	(6.67)	(47.06)	(17.65)	(16.67)	(18.18)	(45.45)	(15.38)	(6.67)	(44.44)	(22.38)
	Perspective	1	4	4	3	2	1	1	1	2	1	0	20
		(9.09)	(22.22)	(26.67)	(17.65)	(11.76)	(16.67)	(9.09)	(9.09)	(15.38)	(6.67)	(0.00)	(13.99)
	Alternative	1	2	2	1	0	0	2	0	2	0	0	10
		(9.09)	(11.11)	(13.33)	(5.88)	(0.00)	(0.00)	(18.18)	(0.00)	(15.38)	(0.00)	(0.00)	(6.99)

Percentages within teacher candidates appear in parentheses below frequencies

Appendix K

Frequencies and Percentages of Idea Units Associated with Different Stances and Topics in Each Reflection

IA	Topic	Stance					
		I	E	D	P	A	Total
1	TI	50	52	48	45	16	211
		(49.02)	(88.14)	(94.12)	(95.74)	(69.57)	(74.82)
	SP	52	7	3	2	7	71
		(50.98)	(11.86)	(5.88)	(4.26)	(30.43)	(25.18)
2	TI	55	39	32	38	19	183
		(59.78)	(97.50)	(96.97)	(100.00)	(90.48)	(81.70)
	SP	37	1	1	0	2	41
		(40.22)	(2.50)	(3.03)	(0.00)	(9.52)	(18.30)
3	TI	53	20	8	15	14	110
		(65.43)	(80.00)	(88.89)	(100.00)	(70.00)	(73.33)
	SP	28	5	1	0	6	40
		(34.57)	(20.00)	(11.11)	(0.00)	(30.00)	(26.67)
4	TI	49	36	31	20	7	143
		(61.25)	(97.30)	(96.88)	(100.00)	(70.00)	(79.89)
	SP	31	1	1	0	3	36
		(38.75)	(2.70)	(3.13)	(0.00)	(30.00)	(20.11)
Total	TI	207	147	119	118	56	647
		(58.31)	(91.30)	(95.20)	(98.33)	(75.68)	(77.49)
	SP	148	14	6	2	18	188
		(41.69)	(8.70)	(4.80)	(1.67)	(24.32)	(22.51)
	Total	355	161	125	120	74	835
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns and IAs appear in parentheses below frequencies

Appendix L

Frequencies and Percentages of Idea Units Associated with Different Stances and the Presence of Evidence in Each Reflection

IA	Presence of Evidence	Stance					
		I	E	D	P	A	Total
1	Presented	97	43	25	45	23	233
		(94.17)	(72.88)	(49.02)	(95.74)	(100.00)	(82.33)
	No	6	16	26	2	0	50
		(5.83)	(27.12)	(50.98)	(4.26)	(0.00)	(17.67)
2	Presented	93	32	11	38	21	195
		(100.00)	(80.00)	(33.33)	(100.00)	(100.00)	(86.67)
	No	0	8	22	0	0	30
		(0.00)	(20.00)	(66.67)	(0.00)	(0.00)	(13.33)
3	Presented	81	21	5	15	20	142
		(98.78)	(84.00)	(55.56)	(100.00)	(100.00)	(94.04)
	No	1	4	4	0	0	9
		(1.22)	(16.00)	(44.44)	(0.00)	(0.00)	(5.96)
4	Presented	82	13	88	20	9	212
		(100.00)	(35.14)	(79.28)	(100.00)	(90.00)	(81.54)
	No	0	24	23	0	1	48
		(0.00)	(64.86)	(20.72)	(0.00)	(10.00)	(18.46)
Total	Presented	353	109	129	118	73	782
		(98.06)	(67.70)	(63.24)	(98.33)	(98.65)	(85.09)
	No	7	52	75	2	1	137
		(1.94)	(32.30)	(36.76)	(1.67)	(1.35)	(14.91)
	Total	360	161	204	120	74	919
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns and IAs appear in parentheses below frequencies

Appendix M

Frequencies and Percentages of Idea Units Associated with Different Stances and Instructional Features in Each Reflection

IA	Instructional Feature	Stance					
		I	E	D	P	A	Total
1	T	8	27	35	38	66	174
		(8.79)	(48.21)	(71.43)	(84.44)	(45.21)	(44.96)
	TS	48	18	7	7	51	131
		(52.75)	(32.14)	(14.29)	(15.56)	(34.93)	(33.85)
	TSC	35	11	7	0	29	82
		(38.46)	(19.64)	(14.29)	(0.00)	(19.86)	(21.19)
2	T	3	15	27	30	1	76
		(4.05)	(40.54)	(81.82)	(78.95)	(5.00)	(37.62)
	TS	25	14	5	7	6	57
		(33.78)	(37.84)	(15.15)	(18.42)	(30.00)	(28.22)
	TSC	46	8	1	1	13	69
		(62.16)	(21.62)	(3.03)	(2.63)	(65.00)	(34.16)
3	T	9	8	6	13	2	38
		(13.04)	(34.78)	(66.67)	(86.67)	(11.11)	(28.36)
	TS	19	5	2	2	4	32
		(27.54)	(21.74)	(22.22)	(13.33)	(22.22)	(23.88)
	TSC	41	10	1	0	12	64
		(59.42)	(43.48)	(11.11)	(0.00)	(66.67)	(47.76)
4	T	3	26	25	19	2	75
		(4.17)	(70.27)	(86.21)	(95.00)	(20.00)	(44.64)
	TS	26	5	3	0	3	37
		(36.11)	(13.51)	(10.34)	(0.00)	(30.00)	(22.02)
	TSC	43	6	1	1	5	56
		(59.72)	(16.22)	(3.45)	(5.00)	(50.00)	(33.33)
Total	T	23	76	93	100	71	363
		(7.52)	(49.67)	(77.50)	(84.75)	(36.60)	(40.74)
	TS	118	42	17	16	64	257
		(38.56)	(27.45)	(14.17)	(13.56)	(32.99)	(28.84)
	TSC	165	35	10	2	59	271
		(53.92)	(22.88)	(8.33)	(1.69)	(30.41)	(30.42)
	Total	306	153	120	118	194	891
		(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

Percentages within columns and IAs appear in parentheses below frequencies