SCIENCE TEACHER DEVELOPMENT AND THE LENS OF SOCIAL MEDIA: AN INVESTIGATION INTO THE IDENTITY AND INFLUENCES UPON THE DEVELOPMENT OF ELEMENTARY PRE-SERVICE SCIENCE TEACHERS

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A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the School of Education (Culture, Curriculum and Change).

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ABSTRACT

Steven D. Wall: Science Teacher Development and the Lens of Social Media:
An Investigation into the Identity and Influences upon the
Development of Elementary Pre-Service Science Teachers
(Under the direction of [Janice L. Anderson])

Pre-service teacher education is committed to the cultivation of different forms of competency that include, but are not limited to, content knowledge and pedagogical skill (Levin, Hammer, & Coffey, 2009; Yerrick, 2005). While advances in practice have been made, pre-service elementary teachers (PS-ESTs) continue to exhibit anxiety and doubt about self-efficacy in science teaching. Teacher education is designed to encourage PS-ESTs to formulate useful practices, but PS-ESTs must first overcome limitations and anxiety generated by past, personal experiences and an acknowledged discomfort with science. While this goal is accomplished through contexts designed with that intent (e.g. methods courses, field experiences), challenges remain. Twenty-first century elementary teacher education research needs to examine influences associated with individual identities within specific roles (Gee, 2000), teaching and learning contexts and their inherent influences, and interactions that are enhanced by the increasing presence and influence of social networks. To examine and better understand identity, contexts, and interactional influences, blogs from two cohorts of PS-ESTs were examined to better understand how teacher education practices influenced PS-ESTs and to determine PS-ESTs beliefs about the teacher's role. The study was designed to answer the following research questions: "What is learned about the identity of PS-ESTs authored through social media, what contextual influences are acknowledged by

PS-ESTs, and what interactions are occurring and what roles are they playing in the development of PS-ESTs?" This study used grounded theory and perceptual control theory (PCT) to analyze and reduce data to make assertions about PS-ESTs' development as teachers and influences upon their practices. Findings illuminated components of PS-EST teaching identities and suggested multiple implications within different domains, including the role of PST understandings of science teaching, the phenomena of science in the schools, perceptions of methodology, the influence of elementary school students, and development through social media. Implications include: 1) utilizing PST understandings of science teaching to generate relevant science teaching; 2) reorienting PSTs to critique past experiences in order to minimize mimicry of them; 3) uniting facilitation denoted by approaches with specific, detailed learning outcomes and developing strategic problem-solving skills by paying attention to details; and 4) instituting specific strategies to utilize student backgrounds in the design of classroom practices.

I dedicate this dissertation to my wife and two sons. For the belief that you expressed in me and the often needed reminders of what is important in life.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CT	Cooperating teacher
ERIC	Education Resources Information Center
F.O.S.S.	Full Option Science System
JSTOR	Journal Storage
NGSS	Next Generation Science Standards
NSTA	National Science Teachers' Association
NOS	Nature of science
PISA	Program for International Student Assessment
PS-EST	Pre-service elementary science teacher
STEM	Science, Technology, Engineering and Math
UbD	Understanding by Design
UDL	Universal design for learning

CHAPTER ONE

Introduction

In order to develop a teaching identity, and thus benefit student learning, pre-service elementary teachers (PS-ESTs) must cultivate different forms of competency that include content knowledge and pedagogical skill (Levin, Hammer, & Coffey, 2009; Yerrick, 2005). Once acquired, these new competencies can enable the PS-EST to formulate ideas useful to student learning. Effective preparation of the PS-EST requires the development of good pedagogical practices that overcome limitations and anxiety generated by the PS-ESTs' personal experiences and an acknowledged discomfort with science teaching, something that is more likely to occur in a context designed with that intent (e.g. a methods course). For this reason, teacher education practices are needed that include consideration of the PS-ESTs' identity, the contexts that are prominent in teacher education, and influences within these contexts. Given the different influences associated with teacher education (e.g. methods courses, field experiences), interactions that occur involving variables such as content-oriented practices, school subcultures, contextual agents (e.g. cooperating teachers [CT], administrators), peers, and academic agents are worth consideration. Coupled with twenty-first century practices, elementary teacher education research is required that considers common components of academic coursework in conjunction with special attention to the following: 1) recognition of influences associated with individual identities within specific roles (Gee, 2000); 2) recognition of teaching and learning contexts and their inherent influences; and 3) recognition of the roles of interactions that are both illuminated and potentially enhanced by the increasing presence and influence of social networks (Luehmann & Borasi, 2011; Yang & Chang, 2012),

The undergraduate PS-ESTs' need for development as a teacher is subject to PS-ESTs' perceptions (Burke, 2007; Burke & Stets, 2009; Powers, 2008) and challenges associated with professional environments (Baggott La Velle, McFarlane, John, & Brawn, 2004; Meier, 2012). Because the undeveloped potential of local school environments has an adverse effect on science teaching practices of new teachers (Baggott La Velle et al., 2004; Meier, 2012; Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012), what occurs during the PS-ESTs' enrollment in methods coursework becomes a crucial component in science teacher development (Marbach-Ad & McGinnis, 2008). PS-ESTs require an increased awareness of the challenges associated with acculturation to science (e.g. Aikenhead, 2001; Solano-Flores & Nelson-Barber, 2001), and though identity is tacitly alluded to in research focused upon science education (e.g. Sewell, St George, & Cullen, 2013; Smith & Jang, 2011; Suriel & Atwater, 2012), an increased emphasis is warranted.

According to Bautista (2011), PS-ESTs' adaptation to academic expectations is an indication of receptivity to new ideas. This willingness is beneficial because the PS-EST that is exposed to good practices also develops new skills. While PS-ESTs display adequate and sometimes exceptional practices in the academic classroom, these practices are provisional; they are rarely emulated during induction years (e.g. Matkins & Bell, 2007). Two reasons for this tendency emerge. First, the PS-EST has a contextually derived identity for teaching science that is dependent upon the scaffolding of the academic subculture (Baggott La Velle et al., 2004; Settlage et al., 2009, Wortham, 2006). Second, given limitations associated with elementary school contexts and the PS-ESTs' own beliefs about their ability to teach science (Burke & Stets, 2009; Lawler, 2008), the context becomes a prominent influence upon how PS-ESTs approach science in the classroom. For example, if the school subculture places emphasis on science, the PS-EST who has a limited self-efficacy with science is more likely to teach in a way that conforms to the school culture. If the PS-EST has an already established belief about and sense of self-efficacy with science, the school subculture is less likely to influence or hinder the PS-ESTs' practice.

Recognizing that an important dialectic exists between contextual variables associated with science teacher education and the practices utilized by those preparing for careers as teachers, research conducted to understand more about PS-EST identities and their perceptions of teaching science at the elementary grade level during undergraduate enrollment is necessary. By delving into the identity of PS-ESTs, effective strategies for enhancing PS-ESTs' understanding of how to teach science can be illuminated. For this dissertation, such research is conducted with knowledge of twenty-first century variables that include PS-EST interactions with each other, the influence of social interactions through digital media, and the prominence of context, content, and the historical cultures of schools (Bourdieu & Passeron, 2000).

Research Questions

The goal of this dissertation is to investigate the development of PS-ESTs in a senior-level cohort and to interrogate variables that are perceived as influences on the PS-ESTs' development as science teachers. This research also examines the social network generated by PS-ESTs blogging with each other. A specific effort is made to incorporate ideas associated with identity to better understand PS-ESTs, the contexts they occupy, and the various interactions that occur between PS-ESTs and students and any other contextual agents. A major assumption is that twenty-first century media are important for the development of teacher education practices because they illuminate the science teaching identity of undergraduate elementary education majors. To contribute to future efforts attuned to this goal, this dissertation seeks to answer the following questions:

1. What is learned about the identity of PS-ESTs authored through social media?
    a. What is learned about PS-EST beliefs?
    b. What is learned about the experiences of PS-ESTs?
2. What contextual influences are acknowledged by PS-ESTs? How do PS-ESTs process and utilize these influences?
3. What interactions are occurring? What roles do these interactions play in the development of PS-ESTs?

Theorizing Identity: What is Science Teacher Identity?

Science teacher identity has two distinct components: a personal comprehension of what conceptual learning entails and the recognition of when to use these skills to insure science learning by others (see Table 1.1). The first trait, content competency, includes both understanding the responsibilities associated with a science teacher's role (e.g. Kuhn, 2000) as well as the personal beliefs associated with the role of scientific knowledge and practice. These two characteristics can be fluid, subject to influences such as contextual preferences for science learning and the individual's perceptions or beliefs about the teacher's role. The second component of a science teaching identity is helping students learn appropriate content and practices. This requires efforts to engage students and develop their critical thinking through science-based activities, authentic questions, scientific knowledge, scientific reasoning, and the use of lab processes and methodologies (ETS, 2012; Science, 1990, 1993, 2012). A set of skills accompany the traits, comprehension of content and helping students learn content and affiliated practices, that comprise a science teacher identity.

Skills. A major presumption for this dissertation is that science teacher identity is manifested in the activities of PS-ESTs engaged with undergraduate coursework. These include the use of appropriate content-neutral or content-specific skills (Appleton, 2008; Bhattacharyya et al., 2009; Hubbard & Abell, 2005) associated with student learning (Zemba-Saul et al., 2000). Skills can be categorized as appropriate for any content teaching and learning or they can be associated with a specific content domain (Appleton, 2008; Shulman, 1987).

Neutral teaching skills involve the continual engagement of students with content, the use of authentic questions, and the development of an ability to problem-solve around issues of pedagogy and content practice (Hilton, 2010). Others include the use of specific types of discourse, responsibility for the work of others (Grier & Johnston, 2009; Kilic & Cakan, 2007; Zemba-Saul et al., 2000), and ability to create a classroom culture conducive to learning (Holland et al., 1998). Student-centered skills involve the use of content-based activities, content knowledge, the use of scientific reasoning, the use of lab processes, and appropriate methodologies accepted by both the epistemic science and science education communities (ETS, 2012; Science, 1990, 1993, 2012). Skills associated with pedagogical ability include complex communication and lesson planning based on multiple levels of understanding of science (Hilton, 2010; Loughran, 2007; Russ & Luna, 2013), acclimation to content knowledge practices (Bhattacharyya et al., 2009; Hechter, 2011; Milford & Tippett, 2013), and alignment with professional expectations (Taranto, 2011). Science teacher identity is demonstrated when the PS-EST exhibits skills that are acknowledged as beneficial to student learning (Milner, Templin, & Czerniak, 2011); these skills are evaluated as beneficial because they help students accomplish desired academic goals (Nebel, 2010). Although important, data associated with this dissertation has minimal information about student academic goals and learning outcomes, though PS-EST reflections through blogging are acknowledged as sources of information about local students.

Table 1.1

Science Teacher Identity

Trait	Example	Reference
Impact the learning of others	-Use of appropriate cognitive or methodological skills Responsibility for the work of others -Able to disseminate knowledge and practices to students in reliable manner	Jones & Carter, 2007; Loughran, 2007; Zemba-Saul et al., 2000; Roychoudhury & Rice, 2010
Content-neutral skill	-The use of authentic questions -Ability to problem-solve around issues of pedagogy -Ability to impact the learning of students	Appleton, 2008; Bhattacharyya et al., 2009; Hubbard & Abell, 2005; Milner, Templin, & Czerniak, 2011
Content-specific skill	-Use of specific types of discourse -Ability to create a classroom culture conducive to learning -Engagement of students with content -Awareness and comprehension of the nature of science -Competencies with epistemic science content	Grier & Johnston, 2009; Kilic & Cakan, 2007; Holland et al., 1998; Abd-El-Khalick, 2001; Akerson et al., 2011; Quigley, Pongsanon, & Akerson, 2010

What is meant by social media?

In the twenty-first century, social media are computer-mediated tools that allow people to create, share, or exchange information, ideas, pictures, and videos in virtual communities and networks. Social media are Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of user-generated content (Kaplan & Haenlein, 2010). For this dissertation the idea of social media is focused on the use of blogging to publish personal reflections on experiences, both historical and current, and comments authored in response to these reflections. **Blogging is the vehicle for data collection and not the focus of this inquiry.** Blogging can be used as a means of enhancing communication among members of a public or private group by extending reflections to an audience consisting of peers (Anderson et al., 2013; Hanuscin, Cheng, Rebello, Sinha, & Muslu, 2012; Wolf, 2010). Blogging also generates opportunities for unique interactions about struggles with teaching practices such as planning, decision-making associated with new experiences, content, and pedagogy (Yang & Chang, 2012). These interactions are the result of public authorship rather than monologues or momentary reflections with an instructor; one intention of blogging is to extend conversations and minimize boundaries and chronological margins (Lieberman & Mace, 2009; Wolf, 2010).

Significance of the Research

Entire journals have been dedicated to understanding teacher education and its role in the development of future educators (e.g. *Journal of Science Teacher Education, Journal of Teacher Education, Teaching and Teacher Education*). A review of research literature attentive to pre-service teacher education reveals how personal and contextual variables shape and perpetuate the teaching identities of PS-ESTs. What is currently understood about the development of elementary PS-ESTs produces a more coherent picture of teacher identity and influences on its development, yet various studies reveal that the role of identity as an analytical lens is minimal (Gee, 2000). Bringing together the research on identity and elementary science teacher education, this dissertation engages in a conversation about the influences of identity and context on development of PS-ESTs specifically as science teachers.

The conversation that this dissertation bounds occurs by specifically looking at components of PS-EST identities, the contexts that the PS-ESTs occupy, and the interactions that occur; these include interactions between individuals and contexts, individuals and content, and individual PS-ESTs with other PS-ESTs or contextual agents (e.g. CTs, instructors, students). While each literature component has received due attention through various research communities, this dissertation focuses on a synthesis that considers how these three distinct influences reveal the identity of the PS-ESTs.

Because the study of identity and the role of social media are unique and independent fields of study, reading the literature as three strands of research is important. These three strands involve: 1) identity associated with the development of pre-service elementary science teachers; 2) contextual influences associated with science teacher education; and 3) the role of community that incorporates the use of blogging. In analyzing the intersection of these three strands, a gap in the literature emerges (see figure 1.1). The scarcity of this research provides the opportunity for current and future researchers to undertake new studies that focus on developing a link between science teaching identity and pre-service science teacher education through the use of social media.

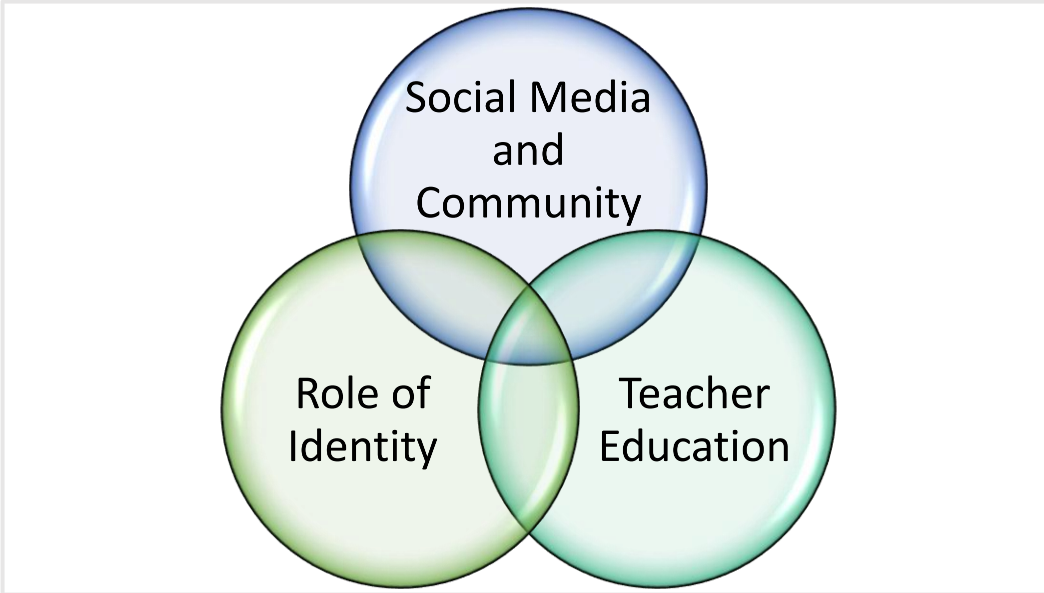


Figure 1.1: Framework for literature review

Impact and Implications

This dissertation study is not about the use of social media, specifically blogging. Data analysis and reduction involves blogging, but the focal point is science teacher identity and how personal identities, methods courses, and field experiences influence the PS-ESTs' development. The PS-ESTs' acceptance and use of science is influenced by components of identity, including beliefs about the salience of accepted roles (Burke & Stets, 2009), and blogging is a vehicle that illuminates these identities. By focusing on the identity of the PS-ESTs, interactions involving individual PS-ESTs, and contextual influences, assertions about the role of teacher education practices and improvement are possible. These roles involve: 1) observing and understanding the internal dynamics of PS-ESTs as individuals and members of a group that have specific roles (e.g. undergraduate, PS-EST); 2) the integration and mediation of contextual inputs as individual PS-ESTs enact perceived roles within a context;

and 3) the influence of contexts upon pedagogical practices that include PS-ESTs as participants in a group interacting through social media. This research can improve understanding of PS-EST teaching identities and illuminate facets of social media use and the role of some experiences in the early career development of science teachers (Hilton, 2010; Windschitl, 2002).

Talking with one another about experiences beyond the scope of the academic classroom through socially mediated “transactional relationships” provides insights into PS-ESTs’ personal thoughts about teaching practices. Because elementary PS-ESTs are experiencing expectations for a new role, their own desires and discussion with each other afford access to new insights, including awareness of collaborative skills. By engaging PS-ESTs in reflections and critiques of themselves, their peers, and contextual experiences (Khan, 2005), this dissertation identifies influences on the development of elementary science teachers and provides ideas for the improvement of teacher education practices designed for their preparation. This study can orient teacher educators toward identity and its associated variables as a research lens, make recommendations for the improved use of social media in teacher education through the integration of identity-shaping factors in blogging practices, and make arguments for the development of meaningful pedagogical practices associated with science teacher education. This research can also encourage discussions about improving teacher education for twenty-first century learning environments (Hilton, 2010).

Limitations of the Study

In addressing the proposed research questions, this dissertation is focused on variables that are alleged to influence the development of peers in an academic cohort. In order to frame the study, a limitation that became apparent was the lack of a uniform standard to evaluate qualitative similarities or differences in the development of PS-ESTs. An effort was made to produce a standard through the analysis of the extant literature. This standard involved looking at PS-ESTs, presuming levels of ability and subjectively evaluating what their reflections and comments reveal about long-term perspectives of science teaching and pedagogy. Seeking to define what was revealed through these reflections and comments led to definition of variables associated with the development of PS-ESTs. However, the process had inherent limitations. First, the standards that were developed came from secondary analysis of published research. Second, the standards were not validated, and while these variables that comprised the standards represented acceptable observations, the ability to explore them was limited. Third, these standards for the evaluation of development involved subjective opinions about what is valuable in defining science teacher identity. Fourth, given the limited range of the data—it was situated within a semester of the undergraduate program of study, any changes in the PS-ESTs presented through reflection could not be deemed a shift in thinking associated with the science teacher role. Determining whether awareness of the role or a shift in understanding occurred was limited because social media are used to produce rudimentary reflections stimulated by authentic experiences (Harland & Wondra, 2011). Though considered a part of the repertoire of a good teacher (Duffy et al., 2010), these reflections are based on scaffolded methods courses and field experience contexts designed to place an emphasis on the learning of how to teach science (Appleton, 2008; Hanuscin, 2013). Essentially, these reflections are an academic expectation, produced by prompts designed to generate some form of response. Though the revelations contained in posts and comments are presumed to illuminate facets of the PS-ESTs' identity, the PS-ESTs are academic performers fulfilling a role as students (e.g. Wortham, 2006) or fulfilling a perceived expectation (Powers, 2005). Essentially the PS-ESTs' responses may reflect the presence or development of an identity standard, but is more likely to represent an increased awareness of what it means to be a science teacher. To presume that findings represent an important shift in the development of the PS-ESTs lacks veracity and truthfulness based on the nature of the data.

Another limitation is that posts and reflections are presumed beneficial to the development of science teacher identity because they extend the science subculture of the methods course and field experiences by valuing communication related to science teaching. However research indicates that identity is contextually derived, and with PS-ESTs immersed in coursework where methodology is championed, discerning a difference between reflection on a common experience because of academic expectations and self-initiated reflection intended to demonstrate individual development is difficult.

Other, imposing challenges arise when considering the role of feedback from the community. Findings related to feedback are dependent upon PS-ESTs responding to one another. This is a challenge acknowledged by previous research that reveals PS-ESTs do not readily accept blogs as a valid means for academic discourse (Anderson et al., 2013). Research indicates that this perception changes over the course of the academic year, but interactions among peers produce a lack of constructive criticism and are individualistic and reflexive rather than group-oriented and conversational (e.g. Harland & Wondra, 2011). The previously mentioned are viewed as constraints with respect to interactions. This constraint is significant when emphasis is placed upon social media as interaction, in much of the literature, is considered one of its affordances. Though a lack of interaction and subsequent feedback is contrary to the goals of using social media, a positive note is that posts authored in response to prompts can be individually beneficial because they represent an identity-driven personal critique related to the PS-EST.

Finally, given the nature of PS-EST posts and comments and how they reflect practices common to inquiry learning such as observation and rational argument, any identity findings that were observed over the course of the blogging period were considered provisional. The rationale for this stance was that PS-ESTs were in a scaffolded academic environment where characteristics were fostered by design. Due to the study's focus on blogs and not what occurred outside the blogs, what happened beyond the scaffolded environment could not be gleaned from the data at hand. The development of long-term practices beyond the academic context was a clear desire, but did not involve observations beyond the context of the methods course or other academically-based practices.

Organization of this Dissertation

The purpose of this study is to understand the development of science teacher identity, and to determine possibilities for future practices. A specific focus is on learning about the PS-ESTs as they experience what occurs in their academic courses, field experiences, and interactions with each other and other contextual agents.

In Chapter Two, there is a critical review of the literature related to identity, teacher education, and social media and community. Because this study is about the identity of PS-ESTs, bodies of research that examine pre-service teachers, influences upon their development, and components of their identity formed the basis of this review. Additional bodies of literature included research or theoretical literature associated with teacher education practices, and the use of social media. These reviews were aimed at informing readers by situating the current study in the context of previously conducted research.

In Chapter Three, the research design and methods that were used for this study are presented: specifically why a qualitative study was undertaken, why perceptual control theory was used to frame the data, and how grounded theory was used to shape the analysis process. The steps taken in collecting and analyzing the data, as well as the rationale behind these steps, are presented. Finally, the integrity of this study is explored by addressing standards for qualitative research.

Chapter Four looks at the findings revealed through the examination of PS-ESTs' blogs. This chapter describes the beliefs and expectations of PS-ESTs, how they process what they are doing and learning during the teacher education experience, and the contextual influences and any interactions generated through the PS-ESTs activities (e.g. with each other, instructors, CTs).

Chapter Five explores how the findings of chapter four work to provide a picture of the PS-ESTs' identities. This chapter discusses the need to use identity as an analytic lens for general teacher education practices, as well as offer insights into the use of blogging in research on teacher preparation. Chapter five also explores the implications of this study's findings for future research and practice.

CHAPTER TWO

Review of the Literature

Answering the primary research questions, "*What is learned about the identity of PS-ESTs authored through social media, what contextual influences are acknowledged by PS-ESTs, and what interactions are occurring and what roles are they playing in the development of PS-ESTs*?" requires a review of various fields of research literature. To address these questions, this dissertation was informed by extant theoretical literature and empirical studies on identity, elementary science teacher education, social media, and community. This literature provided insights about individual identity, contextual influences, and interactions associated with the two, as well as an analytical lens beneficial to the study.

In order to find literature to inform this study, a variety of databases were used, including ERIC, Google Scholar, and JSTOR, and searches utilized terms associated with identity and elementary science teacher education. Social media and community were also considered. Key terms for the searches included *elementary teachers, identity*, *pre-service teachers*, *science*, *science teacher identity*, *teacher identity*. The second search included first search terms in combination with terms pertaining to social media (e.g. *blogging*, *digital media*) and community (e.g. *participatory practices*, *group processes*, and *communities of practice*). Most articles were selected from journals with a primary focus on science teaching or research on teaching and included the following peer-reviewed journals: *The Journal of Teacher Education, The Journal of Science Teacher Education, The Journal of*

Research on Science Teaching, Science Education, The Journal of Technology and Teacher Education, Social Psychology Quarterly, The Journal of Computer-Assisted Learning, The Journal of Computer-Mediated Communication, and *Teaching and Teacher Education.*

Results from the search were hand-checked and selected based on perceived significance to the goal of clarifying what defines a science teacher identity, the role of interactions, and trends deemed important to current science teacher education. Some articles contained research on the practices of in-service teachers, but a majority of them focused on PS-ESTs engaged in practices that included contexts such as labs, methods courses, and pre-service field experiences. Articles that gave prominence to PS-EST responses to teaching practices were surveyed to gain insights into the interactions, affinities, and discourses of learning environments as well as the influence of teaching contexts and contextual agents.

For interactions, articles were considered that contained information and data about the affordances of social media—specifically current or potential uses of blogging and the influence and impact of participatory practices—such as peer interactions, cohorts shaped by group and/or community processes, and the influences of virtual spaces on behavior and learning in various academic contexts. Since a majority of the articles that were reviewed were published in journals pertaining to science teaching or teacher education practices, they were also reviewed to evaluate what practices and influences were common in teacher education courses. Trends that manifested were used to inform and bound analytical approaches to the data collected for the research questions.

The initial intent of this review was to look at social media and community as separate entities. As a result of the review, a shift occurred with social media and community; both were seen as correlated enough to be considered as a single entity. This conflation provided opportunity for a new component of literary analysis: the role of community-oriented peer practices. This conflation was based on three premises. First, social media were perceived either as a means of self-communication through reflection (Killeavy & Moloney, 2010; Lankshear & Knobel, 2006) and academic participation (Anderson et al., 2013) or a means for community interaction centered on peer achievement (Yang & Chang, 2012). Second, there was a scarcity of research that examined social media (e.g. blogging) in teacher education programs that prepare undergraduates to teach science. In a search of major publishing houses, such as Springer© a search using the keyword *blogging* revealed 2,422 results for this form of social media. Of these 2,422 results, only 15 had some relation to education with a specific focus on educational and information technology. Of these 15 articles, none specifically focused on blogging in teacher education. When the search was narrowed to look at specific science education journals, such as the *Journal of Science Teacher Education,* the *Journal of Research on Science Teaching,* or the Taylor and Francis–published *International Journal of Science Education,* only one article with a focus on blogging was found. This lone article focused not on the role of blogging but the broader idea of digital fluency associated with increased usage of technology by youth (Hsi, 2007). A third reason for the conflation of blogging and community was that blogs are authored with the intent of community involvement or recognition by community members (Sawmiller, 2010). An ancillary rationale for this conflation was that this dissertation construed social media as a new component of teacher education associated with the development of teaching identities and a new form of literacy amongst members of a cohort. Conflation was both reasonable and warranted because these new practices served to enhance the functions of schools and learning, with science and mathematics education among contexts yet to be adequately explored (Luehmann & Borasi, 2011),

Though teacher education encompasses a large body of research, few articles specifically address the influence of individual identities on the development of science teachers. This limitation occurs even as research and awareness of identity is increasing (Akkerman & Meijer, 2011). Like teacher development and identity, a similar trend occurs with education and the use of social media. The gaps generated by synthesizing knowledge associated with this literature represent a unique, undeveloped area in science teacher education research (see Figure 2.1). Based on the need to address this gap, the literature was reviewed to generate a bibliographic index and themes that could be applied to the analysis and reduction of data about the identity of prospective teachers within the context of blogging, a form of social media.

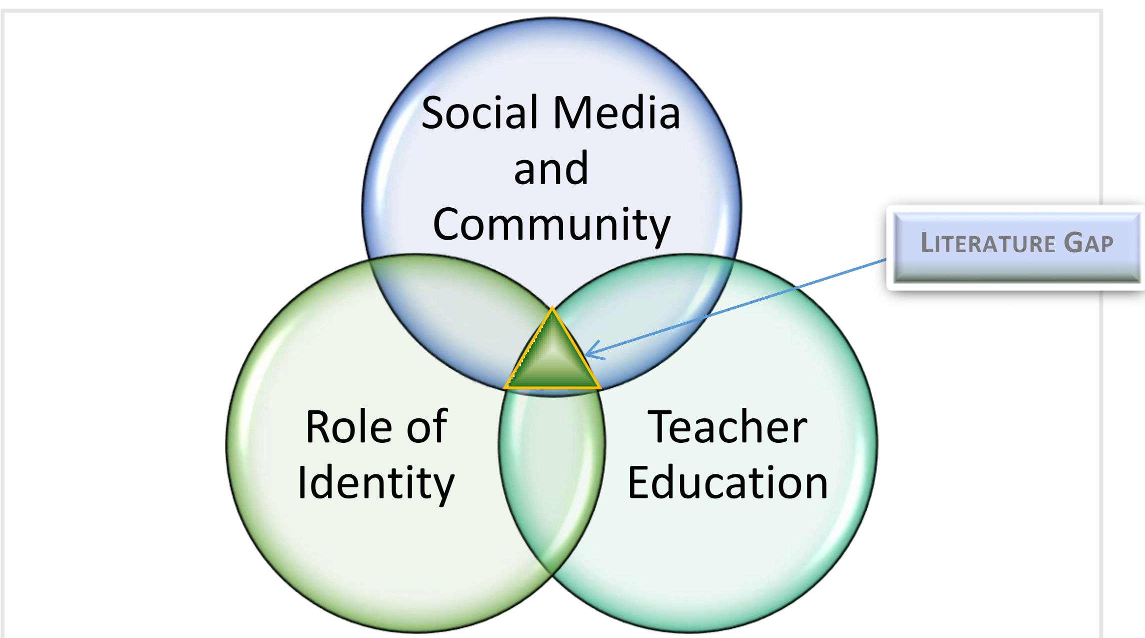


Figure 2.1: Literature gap identified

Identity

Researchers who study teacher identity have built their work on the presumption that being recognized by self or others as a certain kind of teacher is a foundation for teacher identity (Gee, 2000; Luehmann, 2007, 2008; Luehmann & Tinelli, 2008; Sutherland, Howard, & Markauskaite, 2010). Luehmann (2007) noted widespread features associated with identity. These features included identity as fluid (Enyedy, Goldberg, & Welsh, 2006), continuously constructed and reconstructed in social contexts (Holland, Lachicotte, Skinner, & Cain, 1998), and as constituted in the interpretations and narrations of individuals' practices in certain roles (Lave & Wenger, 1991; Lemke, 2000; Sfard & Prusak, 2005). Similarly, notions of professional identity included the idea that it is a non-fixed entity reinterpreted through experiences, that it is formed through interactions between individuals in the context of practice, and that it involves human agency and sets of sub-identities (Beijaard, Meijer, & Verloop, 2004). Moore's (2008) research illuminated the complexity of a specific identity, science teacher identity; a science teacher identity integrated multiple, different perceptions of the world and the role of science teachers.

Science teacher identity is defined by the presence of content-specific skills and knowledge (Guillaume, 1996; Luft & Patterson, 2002), awareness of sociocultural influences on teaching and learning, personal preferences to engage students in learning science, and individual generation of outcomes affiliated with science learning. Contextually, science teacher identity is bound by both the opportunity structures generated by content (Enyedy, Goldberg, & Welsh, 2006; Nilsson & Loughran, 2011; Weld & Funk, 2005) and the sociocultural contexts in which science teaching and learning occur.

Whether obvious or subtle, teacher identity variables were classified as components of relevant structures, associated with contexts in this dissertation, or manifestations of personal agency (Cole, 1996; Daniels, 1996; Vygotsky, 1996; L. Vygotsky, 1978). Examples of contextual variables included elementary school classrooms, content knowledge discourses among teachers or other professionals (Akerson, Buzzelli, & Eastwood, 2011; Baggott La Velle, McFarlane, John, & Brawn, 2004; Holland, Skinner, Lachicotte, & Cain, 1998; Howes, 2002), and race and culture (Parsons, 2008), and roles (Anderson et al., 2013). Examples of variables related to personal agency include beliefs about the teacher's role (Book, Byers, & Freeman, 1983), the development of skills important to science teaching (Zemba-Saul, Blumenfeld, & Krajcik, 2000) and efforts to participate in environments that aid the development of appropriate understandings of science teaching (Barab, Barnett, & Squire, 2009).

Agency

Agentic influences or traits were defined as those that viewed the individual as the center of organizing or activity. These traits were not limited to activity and could involve a form of self-regulation or self-reflection that governed activity that occurred. Agency essentially encompassed individual influences and included traits associated with teachers. In the literature, agency involved the following categories: a) personal beliefs (Bryan & Atwater, 2002; Duffy et al., 2010); b) personal experiences (Loughran, 2007); c) independent dimensions of personal conceptions; and d) approaches to handling new conceptions (Chinn & Buckland, 2011; Hofer & Pintrich, 1997; Nussbaum, Sinatra, & Poliquin, 2008). While not an exhaustive list, the most frequently mentioned variables are listed in Table 2.1 and Table 2.2). While theoretical literature acknowledges agency as activity or action, the decision was made that mental constructs like perceptions and beliefs that preceded action constituted a component of agency.

Table 2.1

Individual Traits

Definition or Trait		Pre-service Trait	Experienced Trait	Sources
Pre-conceived notions (Role of Knowledge)	Involves the nature of knowledge, including its validity, scope, and its foundations; influenced by the veracity of knowledge; subject to the belief of the individual; influences beliefs an individual holds about the nature of knowledge and its production	-Tacit and fixed -Established by entrance into undergraduate practice -Knowledge and skill are secondary to interpersonal relationships -Limited content understanding -Anxiety -Self-doubt; lack of self-efficacy -Produces highly routinized/mimetic behavior -Knowledge is established; lacks ambiguity and unlikely to change -Knowledge is derived from context versus personal expectation -Prefers resolution versus unresolved questions -Absolutist -Multiplist	-Malleable -Established, but resolved to expand (breadth and depth) -Established content understanding; increased desire to establish content understanding -Interpersonal relationships are acknowledged, yet knowledge comprehension drives the nature of the relationship -High degree of self-efficacy -Knowledge is truthful, yet tentative -Values unresolved questions as opportunity for inquiry -Evaluativist	Dweck, 2000; Hofer & Pintrich, 1997; Fajet, Bello, Leftwich, Mesler, & Shaver, 2005; Spector & Strong, 2001; Gunning & Mensah, 2011; Settlage, Southerland, Smith, & Ceglie, 2009; Appleton & Kindt, 2002; Beijaard, et al., 2004; Bianchini, 2000; Bleicher, 2007; Akerson, et al., 2011; Matkins & Bell, 2007; Smagorinsky, Cook, Moore, Jackson, & Fry, 2004; Howes, 2002; Nilsson & Loughran, 2011; Salter & Atkins, 2011; Varrella & Veronesi, 2004; Kuhn, et al., 2000; Chinn & Buckland, 2011; Joram, 2007
Belief	-Acceptance by the mind that something is true or real, often reinforced by an emotional or nonphysical sense of certainty -Can be negotiated	-Generate personal expectations -Benefit to teaching practice unclear -Focus on teacher role based on relationships and well-being of students; minimizes content-oriented practices -Contain naïve assumptions about teaching practice -Negotiated with context -For development as a teacher, rely upon a heavily scaffolded environment -Produce hesitancy with new practices -Diminished competency outside a scaffolded context -View coursework as academic versus training as professional -Unlikely to change until experience/personal preference dictates need -Influence perceptions	-Generate personal expectations -Shape teaching practice -Focus on role of teacher as a guide and a facilitator of learning associated with the content domain -Capable of producing scaffolded environments for student learning -Embrace new practices and effectively evaluate their benefit -See academic work as a method of refining/improving practices -Have recognized that change is a component of development -Influence perceptions and dictate types of experiences that occur or that are sought	Jegede & Aikenhead, 1999; Jegede & Okebukola, 1991; Fairbanks, et al., 2010; Bryan, 2002; Bryan, 2003; Danielowich, 2012; Bryan, 2003; Ohana, 2004; Levin, Hammer, & Coffey, 2009; Warburton & Torff, 2005; Brown, 2010; Erickson, 2007; Wiggins & McTighe, 2006; Hanuscin, 2013; Burke & Reitzes, 1981; Stryker & Serpe, 1994; Baggott La Velle, et al., 2004; Meier, 2012; Allen, 2003; Hubbard & Abell, 2005; Powers, 2005; Yoon et al., 2006; Quinn, Anderson, Atwater, & Bell, 2011; van Zee, 2001; Marbach-Ad & McGinnis, 2008; Patchen & Crawford, 2011; Kang, 2007; Tsai, 2004; Anderson, et al., 2013; Sackes & Trundle, 2013; Book, Byers, & Freeman, 1983; Wortham, 2006;

				Southerland, Sowell, & Enderle, 2011; Moore,
Experience	-Active involvement in an activity or exposure to events or people over a period of time that leads to an increase in knowledge or skill	-Generate beliefs -Historical or contemporary -Type of experience influences perception; -leads to development of preconceptions -can be affiliated with science outside teaching (2nd career) -Quality of experience makes a difference in practice and perception; generally prevalent with early experiences versus later -Longevity of impact is subjective; later the experience the less likely it is to remain prominent	-Generate beliefs -Historical and contemporary are viewed as informative -Perceptions of own PCK influence the type of experiences that are sought -Quality of experience is evaluated, embraced, or discarded based on perception -Longevity of impact is subjective because experience may have neutral value; largely based on whether experience adds value or increases work unnecessarily	Czerniak, Lumpe, & Haney, 1999; Hechter, 2011; Weld & Funk, 2005; Smith & Jang, 2011; Adamuti-Trache & Andres, 2008; Milford & Tippett, 2013; Marble, 2007; Bhattacharyya, Volk, & Lumpe, 2009; Jones & Carter, 2007; McDevitt, Troyer, Ambrosio, Heikkinen, & Warren, 1995; Grier & Johnston, 2009; Bautista, 2011; Ohana, 2004; Stets & Carter, 2011; Feldman, Divoll, & Rogan-Klyve, 2009; Velthuis, Fisser, & Pieters, 2013; Zemba-Saul, Blumenfeld, & Krajcik, 2000; Feldman, et al., 2009; Milford & Tippett, 2013; Salter & Atkins, 2011; Meier, 2012; Luft & Patterson, 2002; Thomas 2011; Capobianco & Feldman, 2010

Structure

For this dissertation structure was defined as physical spaces, materials used, the discourse of contexts, the social, curricular, or even assessment practices affiliated with science education. Whether obvious or subtle, research indicates that influences on science teaching were generated, in part, by established roles and expectations (Burke & Stets, 2009; N. H. Kang, 2008). The idea of structure encompassed national standards (Aydeniz & Southerland, 2012; Eick, 2009; NRC, 1996; NSTA, 2000; Science, 1993, 2012), scientific methodologies, and expectations for how and why knowledge is disseminated (Eick, 2009; NRC, 1996; Taubman, 2009; Williams et al., 2008; Yager, 2005). These were incentives that were easily recognized and acknowledged components of science teaching, yet less acknowledged variables also manifested, including group affinities (Luehmann & Tinelli, 2008), group discourses (Gee, 2000), individual associations over time (Jackson & Seiler, 2013), and recognition by others (Luehmann, 2002; Luehmann & Tinelli, 2008; Luehmann & Borasi, 2011; Sutherland, Howard, & Markauskaite, 2010).

Table 2.2

Contextual Traits

Trait	**Sources**
National Standards	AAAS, 1993, 2012; Aydeniz & Southerland, 2012; Eick, 2009; NRC, 1996; NSTA, 2000; Taubman, 2009
Methods for scientific knowledge creation and dissemination	Eick, 2009; NRC, 1996; Williams et al., 2008; Yager, 2005
Group affinities and discourses, recognition by group, role interpretation, contexts	Gee, 2000; Luehmann, 2002; Luehmann & Borasi, 2011; Luehmann & Tinelli, 2008; Sutherland, Howard, & Markauskaite, 2010; Jackson & Seiler, 2013

Interactions

Using established conceptions of identity, an additional influence is noted, interactions. Interactions are based on the idea that structures and agency collide or collaborate because of a perceived necessity. Interactions are a dialectic between structure and agency that illuminates what activity (e.g. science teaching) is appropriate by using historical patterns of practice (Gutierrez & Calabrese Barton, 2015). The idea being that identity (e.g. science teacher) is both enabled and constrained by social structures that reinforce patterns of social relations (e.g. what does it mean to be a science teacher?).

The interactions produced by this structure and agency dialectic are based upon multiple assumptions: 1) an established role defined by historical traditions or community of practice; 2) an individual acting in accordance with said role; and 3) a component of context that produces an interpretation of that role or a force upon that role. One governing presumption is that at least two components interacting generate an influence that would shape practices or perceptions of the role.

Individual Identity

Individually, teaching identities involved several factor as previously discussed. This dissertation investigates personal beliefs and personal experiences about science content and science teaching (Beijaard, Meijer, & Verloop, 2004; Friesen & Besley, 2013) (See Table 2.3).

Identity Involves Preconceived Notions

Though abundant ideas exist for understanding the influence of preconceived notions about science content and science teaching, the work of Dweck (2000) and Schommer (1997) applies to practices generally associated with education because of the acceptance of two factors: individual malleability (Dweck, 2000) and belief systems that determine the acceptance of new understandings (Hofer & Pintrich, 1997). These two factors are important for teacher education practices because they indicate sites for intervention such that the development of expertise in science content and science teaching through praxis is possible (Sandoval, 2005).

The research on science teacher education often reveals that PS-ESTs have both tacit and fixed expectations for science content and science teaching that are well established by the start of undergraduate work (Fajet, Bello, Leftwich, Mesler, & Shaver, 2005). Teaching is conceived of as a task involving affective, interpersonal relationships rather than a professional practice that requires the practitioner to be both skilled and knowledgeable. The result of such conceptions is that PS-ESTs face the task of teaching science with a minimal understanding of the role of content, a degree of anxiety (Spector & Strong, 2001), and limited degrees of self-efficacy (Gunning & Mensah, 2011; Settlage, Southerland, Smith, & Ceglie, 2009). Angst is usually generated by self-doubt (Dweck, 2000) and a variety of bad experiences (Gunning & Mensah, 2011) that include the use of mimetic and worksheet-oriented practices that mirror what PS-ESTs have personally experienced or that occurred during their own undergraduate teacher education experiences.

Even though authentic science practices in which content knowledge is preeminent occur in academic coursework and field experiences are based on scientific norms like rational argumentation, inference, and skepticism (Appleton & Kindt, 2002; Beijaard et al., 2004; Bianchini, 2000; Bleicher, 2007), PS-ESTs maintain perceptions of the classroom as a place where knowledge and learning should not be ambiguous in nature, showing preferences for correct answers over unresolved questions, even when practice runs at science teaching produce ambiguous yet meaningful opportunities for students to embrace inquiry (Akerson et al., 2011; Bianchini, 2000; Matkins & Bell, 2007; Smagorinsky, Cook, Moore, Jackson, & Fry, 2004). These tendencies in PS-ESTs are contrary to traits typically associated with a science teacher identity, making a deliberate effort to transition PS-ESTs' conceptions of knowledge and knowledge-based practices (Duit & Treagust, 1998; Leach & Scott, 2008; Miller, 2011; Vosniadou, 2008) one of the goals of teacher education.

The evidences presented by research reveal that PS-ESTs have a predilection for fixed practices (Appleton & Kindt, 2002; Bianchini, 2000; Eick, 2009; Fajet et al., 2005) and a preference for mimetic routines, specific results, and correct answers (Bianchini, 2000; Howes, 2002; Nilsson & Loughran, 2011; Salter & Atkins, 2011). Though prevalent, the idea behind teacher education is to challenge these PS-EST misconceptions of teaching

(Joram, 2007) so that upon graduation, PS-EST practices are more aligned with scientific practices and pedagogies beneficial to student learning (Akerson et al., 2011; Enyedy et al., 2006; Yager, 2005). Upon induction into professional service, the PS-EST will ideally have habits that are key to a lifetime of development as a science teacher (Varrella & Veronesi, 2004). For this to occur, PS-ESTs must respond to the prompting of their scaffolded undergraduate courses by relinquishing already established presumptions about science teaching that tend to encumber beneficial dispositions (Varrella & Veronesi, 2004).

Differences observed among members of undergraduate cohorts can be linked to individuals' preexisting views about science content and science teaching, including perceptions that align with the accepted canons and those that do not (Nussbaum et al., 2008). Both inconsistences in understanding and the misconceptions they often generate seem directly related to PS-ESTs' level of anxiety, their expertise, the correctness of understanding, and individual willingness to assimilate new conceptions previously not held (Kuhn et al., 2000). Hopefully, PS-ESTs will have strong conceptions of science regarding sources of knowledge and their associated values, yet realistically this does not occur (N. H. Kang, 2008; Tsai, 2004). Given the fact that PS-ESTs do not exhibit traits desirous of a science teacher, the role of teacher education programs is defined. Ideally, a sound program affords PS-ESTs an opportunity to develop new skills while also producing high degrees of self-efficacy with how to teach science in association with a focus on knowing content.

Identity Involves Personal Beliefs

One of the challenges to changes in conception and practices are beliefs that often influence science learning (Jegede & Aikenhead, 1999; Jegede & Okebukola, 1991). For PS-ESTs, beliefs are strong encouragements (Fairbanks, et al., 2010) that influence approaches to teaching, generating personal expectations about content knowledge and practices (Howes, 2002); they also lead to personal theories about knowledge and the process of knowing (Hofer & Pintrich, 1997). Beliefs are psychologically held and derived from personal experience or cultural sources of knowledge transmission (Bryan, 2002). They are not resolute, with indicators revealing that a belief can be negotiated (Warburton, 2005). When subjected to specific contexts, beliefs produce dispositions about what is experienced and whether or not it should occur in the manner that it does. These dispositions produce disruptions because established practices conflict with what is accepted (Danielowich, 2012).

For PS-ESTs, beliefs about teacher roles are established prior to enrollment in undergraduate work, with the PS-ESTs' ability as a science teacher requiring further development (Warburton, 2005). Beliefs about teaching need to be conceptually challenged because of their basis in naïve assumptions (Abruscato & DeRosa, 2010; Miller, 2011), which stem from personal histories (Bryan, 2003; Fairbanks, 2010); if placed on a spectrum of expertise, they would primarily occupy a level of proficiency classified as novice (Ohana, 2004). Though some exceptions exist (Levin, Hammer, & Coffey, 2009; Warburton & Torff, 2005), the general trend is that PS-ESTs learning to teach science have novice-level ideas about classroom organization and practices (C. P. Brown, 2010; Erickson, 2007; Wiggins & McTighe, 2006) that undergo development during undergraduate and induction experiences (Hanuscin, 2013), but unless PS-EST beliefs about science learning and related practices are confronted, challenges will manifest upon induction into service.

Though beliefs are often negotiated within specific contexts (Burke & Reitzes, 1981; Stryker & Serpe, 1994), the influence of the scaffolded academic environment designed to encourage effective practices is generally not mirrored in established school contexts

(Baggott La Velle et al., 2004; Meier, 2012). Because of this contextual component to establishing or perpetuating belief-oriented practices, ideal PS-ESTs are ones whose views about the development and maintenance of effective practices (Allen, 2003, Bryan, 2002; Bryan, 2003; Fairbanks, 2010) are established prior to their introduction to contexts associated with their future roles as teachers.

PS-ESTs viewed as having beliefs conducive to effective teaching exhibit an ability to organize the classroom around meaningful practices intended to enhance learning (Duffy et al., 2010). Those needing development exhibit a preference for mimetic routines and rigid expectations (Levin et al., 2009), along with a perspective that learning science is not about pedagogical and content skills (Hubbard & Abell, 2005). Minimal beliefs result in limited self-efficacy, but are neither insurmountable nor construed as dislike of science. However, they do represent somewhat fixed perspectives (Yoon et al., 2006) that lead to self-doubt (Dweck, 2000). The PS-EST requires contexts that scaffold and model authentic science teaching experiences to help alleviate this self-doubt (Quinn, Anderson, Atwater, & Bell, 2011; van Zee, 2001).

Though scaffolded experiences are important in developing skill, PS-ESTs' beliefs are deeply ingrained and strongly influenced by past personal experiences that occurred well before the beginning of academic coursework (Bautista, 2011; Bryan, 2003; Bryan & Atwater, 2002; Enyedy et al., 2006; N. H. Kang, 2008). These past personal experiences influence the PS-ESTs' perceptions of knowledge, language, and practice (Hubbard & Abell, 2005; Yoon et al., 2006). These beliefs generate a reluctance to integrate new practices beneficial to teaching science (Akkerman & Meijer, 2011; T. Brown, 2006; Bryan, 2003; Bryan & Atwater, 2002), which is an impediment to science teacher identity development.

This hindrance also produces a diminished competence in the PS-EST once they are beyond the scaffolding of academic courses (Bautista, 2011; Marbach-Ad & McGinnis, 2008; Matkins & Bell, 2007; Patchen & Crawford, 2011).

When PS-ESTs are exposed to experiences related to the teaching of science, a frame of reference for what successful teaching involves is developed (Kang, 2007; Tsai, 2004). However, change occurs only after the PS-ESTs integrate practices into their own repertoires as teachers. The immediacy of new knowledge about teaching makes it salient, yet if the PS-ESTs do not have a strong belief associated with the value of what is observed, what is integrated will be temporary. The PS-EST relies heavily on the academic classroom or the field experience to derive science teaching practices (Anderson et al., 2013; Sackes & Trundle, 2013), but these experiences are academically based and do not easily transfer because PS-EST beliefs that existed prior to the academic experience produce predispositions (Book, Byers, & Freeman, 1983; Wortham, 2006). These priors trigger other beliefs and perceptions about the roles and duties of students and teachers (Book, Byers, & Freeman, 1983; Moore, 2008), resulting in hesitation or doubt about ability to teach science when new experiences occur. Beliefs can also influence what is integrated, sometimes minimizing the value of what is observed in the academic classroom (Adamuti-Trache & Andres, 2008; Bautista, 2011; Warburton & Torff, 2005).

Change is difficult because PS-ESTs are unlikely to relinquish beliefs beyond what is expected academically. As a result, exposure to different practices and scenarios designed to remedy potential hindrances to PS-EST science teaching seem short-lived (Luft & Patterson, 2002; Matkins & Bell, 2007; Patchen & Crawford, 2011). PS-EST beliefs remain influential throughout academic coursework, producing idealized interpretations of teaching practices that are strongly held (Bryan, 2003) and unlikely to be altered by brief academic or field experiences (Akerlof & Kranton, 2010; Book et al., 1983; Jegede & Aikenhead, 1999; Jegede & Okebukola, 1991; Moore, 2008; Parsons, 2008). What endures in the PS-ESTs' own practices is unlikely to change until a level of competence is present that promotes an individual desire to change what is ineffective (Southerland, Sowell, & Enderle, 2011). This makes the role of teacher education and its ability to help PS-ESTs negotiate new beliefs vital to the practices and development of how to teach science for future classrooms, requiring research and development of practices specifically designed to address development.

Identity Involves Personal Experiences

Beliefs are also generated by experiences with their influence determined, in part, by when they occur (Czerniak, Lumpe, & Haney, 1999). Beliefs, once established, influence individual perceptions of roles and practices: These perceptions involve experiences beyond the scope of scaffolded undergraduate courses designed to influence individual competency with content and the teaching of content (Hechter, 2011; Weld & Funk, 2005). To aid PS-ESTs' development as science teachers, undergraduate experiences should be aligned with content values and practices conducive to learning science in school (D. Smith & Jang, 2011). These science experiences can determine preferences for science at an early age (Adamuti-Trache & Andres, 2008; Milford & Tippett, 2013) or lead to the redirection of academic goals during undergraduate coursework (Marble, 2007). Whether an inquiry-based field experience or an early childhood one, the hope is that experiences increase the personal agency of the PS-EST (Bhattacharyya, Volk, & Lumpe, 2009; Jones & Carter, 2007), help them in the conceptualization of science as part of school activity (McDevitt, Troyer, Ambrosio, Heikkinen, & Warren, 1995), and aid in the production of teaching activities that enhance student content conceptions through thoughtful practices (Levin et al., 2009)

Types of experiences are varied and though not evidenced by all PS-ESTs do include individuals with science knowledge from a previous career (Grier & Johnston, 2009). Such individuals have a professional identity shaped by non-scholastic, work-related conceptions of science and exhibit distinct content advantages because their knowledge and understanding is more developed through their careers (Grier & Johnston, 2009). This exposure helps PS-ESTs recognize that science teaching is a practice that transfers beyond the classroom (Bautista, 2011; Ohana, 2004; Stets & Carter, 2011). Though beneficial, the expertise derived from science-related careers does not guarantee the development of a science teacher identity because pedagogical skills unique to classroom science differ from those that are derived from lab-based or other science-related careers (Feldman, Divoll, & Rogan-Klyve, 2009; Grier & Johnston, 2009).

Much more common to PS-EST cohorts are undergraduates who lack experience in science-related careers. Additionally, they are newly exposed to ideas associated with science teaching. Though each PS-EST comes to academic coursework having already experienced science in an educational capacity, mostly during high school or undergraduate education (Feldman et al., 2009; Velthuis, Fisser, & Pieters, 2013), these experiences represent limited exposure to effective science teaching (Levin et al., 2009), imparting minimal information and few beneficial skills for the PS-ESTs' future teaching roles (Duffy et al., 2010; Feldman et al., 2009). Coupled with personal beliefs (Hofer & Pintrich, 1997; Stryker, 1987) that already encumber PS-ESTs' conceptions of science teaching, challenges associated with the developmental experiences of PS-ESTs (Book et al., 1983; Weld & Funk,

2005) can be overcome through the use of salient, contextual influences (Burke & Stets, 2009) (e.g. methods courses and field experiences).

Academic coursework is one of the most salient influences on PS-ESTs, and when designed to aid PS-ESTs' conceptualization of science teaching, can produce some level of self-efficacy (Bautista, 2011; Czerniak et al., 1999; Milford & Tippett, 2013; Velthuis et al., 2013; Zemba-Saul, Blumenfeld, & Krajcik, 2000). For example, the methods course is designed by expert educators to provide experiences with the organization and integration of meaningful content, cognitive and physical practices, and the use of scientific discourse (Akerson et al., 2011; Bryan, 2003; Howes, 2002), which helps the PS-EST develop skills for engaging students in the use of inquiry, lab methods, scientific reasoning, the acquisition of and participation with content knowledge, and critical thinking. Good experiences such as these help individuals engage with methods because they aid conceptualizations of science as an empirical process, a creative activity, and an opportunity to make sense of the world (Milford & Tippett, 2013; Salter & Atkins, 2011; Velthuis et al., 2013). These good experiences also influence attitudes toward science that minimize unnecessary routines while aiding conceptualization of science as part of everyday life (Nilsson & Loughran, 2011). Good experiences help individuals develop schema for future teaching practices, but PS-ESTs often lack such experiences, which in turn produces hesitancy or discomfort with science teaching (McDevitt et al., 1995; Meier, 2012).

The PS-ESTs' adherence to practices during methods coursework also diminishes once the PS-ESTs exit the academic context, indicating that minimal long-term benefit is produced by academic coursework (Capobianco & Feldman, 2010; Howes, 2002; Matkins & Bell, 2007; Nussbaum et al., 2008; Patchen & Crawford, 2011). Though methods course activities and learning are designed with knowledge of beneficial practices in mind, there is little research that is focused on the identity of the PS-ESTs as they undergo these experiences. Methods courses and field experiences provide good authentic opportunities for development (Luft & Patterson, 2002), yet the identities of the PS-ESTs are problematic because they produce values contrary to what aids the PS-ESTs' development of how to teach science (Bautista, 2011; Milford & Tippett, 2013; Ohana, 2004; Thomas, 2011; Velthuis et al., 2013). Based on what is known from the existent literature, careful consideration of PS-EST identities warrant systematic study.

Table 2.3

Agency and Individualism

Tenet	Reference
Identity is Individualistic	Enyedy, et al., 2006; Gee, 2000; Luehmann & Tinelli, 2008; Burke & Stets, 2009
Identity Involves Preconceived Notions	Dweck, 2000; Hofer & Pintrich, 1997; Fajet, Bello, Leftwich, Mesler, & Shaver, 2005; Spector & Strong, 2001; Varrella & Veronesi, 2004; Kuhn, et al., 2000; Chinn & Buckland, 2011; Joram, 2007
Identity Involves Personal Beliefs	Danielowich, 2012; Bryan, 2003; Ohana, 2004; Levin, Hammer, & Coffey, 2009; Burke & Reitzes, 1981; Stryker & Serpe, 1994; Book, Byers, & Freeman, 1983; Wortham, 2006; Southerland, Sowell, & Enderle, 2011
Identity Involves Personal Experiences	Hechter, 2011; Smith & Jang, 2011; Adamuti-Trache & Andres, 2008; Milford & Tippett, 2013; Marble, 2007; Bhattacharyya, Volk, & Lumpe, 2009; Jones & Carter, 2007; Ohana, 2004; Stets & Carter, 2011; Feldman, Divoll, & Rogan-Klyve, 2009; Velthuis, Fisser, & Pieters, 2013; Zemba-Saul, Blumenfeld, & Krajcik, 2000; Capobianco & Feldman, 2010

Structural Influences

An important component of teaching identity is the context PS-ESTs occupied. Contexts affiliated with the development of the PS-ESTs involve social, cultural, or curricular stimuli (See Table 2.4) with their salient influences generating expectations that frame the actions and expectations of the PS-ESTs as they go about preparations for field experiences or the accomplishment of other academic goals.

Cultural Contexts

PS-ESTs are influenced by experiences and practices that take place in contexts with established cultural histories (Bourdieu & Passeron, 2000) (see Table 2.4). These influences are the result of established expectations and encourage PS-ESTs to engage in accepted activities (Kincheloe, McKinley, Lim, & Calabrese Barton, 2006). Including individuals with STEM backgrounds (Grier & Johnston, 2009), these contexts are strong influences upon PS-EST practices and perceptions (Meier, 2012) for two reasons. First, each PS-EST is joining an affinity group/cohort with similar perceptions and limitations. Second, the contextual values beyond the methods course, typically associated with elementary school, are not known for their encouragement of science teaching practices (Baggott La Velle et al., 2004; Bautista, 2011; Hechter, 2011; Kincheloe et al., 2006; Settlage et al., 2009).

Contextual values are shaped by cooperating teachers (CT) (Forbes, 2013; Sadler, 2006), the age/grade level of students, subject specialization, and school-wide attitudes toward science (Matkins & Bell, 2007). They produce expectations extrinsic to PS-ESTs, while generating an opportunity structure (Burke & Stets, 2009) that stimulates growth as a science teacher. Though not guaranteed, the hope is that these contexts have properties that challenge the PS-EST to reconcile dissonance (Akkerman & Meijer, 2011) and to accommodate new and important perceptions of teaching and learning (Abruscato & DeRosa, 2010; Miller, 2011).

According to Bautista (2011), PS-ESTs adapt to the expectations of academic environments, which is an indication of receptivity to new ideas. Given the acknowledged limitations of PS-ESTs, these extrinsic influences and PS-ESTs' willingness to adapt mean that the academic environment, characterized as having a strong science subculture, encourages progress as a science teacher (Feldman et al., 2009; Forssell, 2009; Hansen, 2008). This evolution produces an identity typified by the use of practices beneficial to student learning (Barab, Barnett, & Squire, 2009; Feldman, et al., 2009; Matkins & Bell, 2007; McDevitt, et al., 1995; Spector & Paschal, 2001). Unfortunately, the influences that PS-ESTs are afforded during their academic careers are not paralleled in an elementary school culture, a limitation that is challenging because the role of context is important in defining roles and practices. Basically, the PS-EST is exposed to extremes. In the academic subculture, good provisional influences are generated through scaffolded academic expectations regarding science and science teaching, while elementary school settings are collared with a culture defined by alternative values.

Elementary schools are generally defined by expectations of peers or colleagues that fail to encourage effective science teaching practices. This limitation often begins with the cooperating teacher (CT) (Rozelle & Wilson, 2012) tasked with the oversight and professional encouragement of the PS-EST. The PS-EST is influenced by numerous personal interactions with the CT (Sadler, 2006), and the CT is a perceived exemplar of the academic subculture (Forbes, 2013; Sadler, 2006). Though knowledgeable, experienced, and effective in their teaching, CT views often produce a limited focus on science (Luft &

Patterson, 2002), minimizing potential positive impacts with respect to science teaching on the PS-EST's development. Rather than the somewhat messy and ambiguous practices associated scientific practices (Smagorinsky et al., 2004), CTs utilize routinized practices that marginalize skills inherent to science teaching.

CT's classrooms are typically defined by a high frequency of mimetic and routinized classroom activities that are a result of personal preferences (Milner et al., 2012) or an emphasis upon standards-based assessment and instruction influenced by national discourses (Eick, 2009; Milner et al., 2012). Though PS-ESTs are known to offer critiques while engaged in such contexts, these critiques are often short-lived, lasting the span of the academic requirement that generates the interaction. Critique can also be subdued by variables that extend beyond the CT's control, such as an emphasis on teaching according to test scores (Aydeniz & Southerland, 2012; Taubman, 2009). Though critiques are a stance, indicating strong beliefs or perceptions, the lack of a meaningful experience does little for the maturation process associated with good science teaching (Bhattacharyya et al., 2009; Salter & Atkins, 2011; Weld & Funk, 2005). Instead, research indicates that the PS-EST is indirectly pressured to mirror exemplified CT practices or the school's cultural values (Eick, 2009; Yager, 2005) primarily because of the PS-ESTs' lack of experience.

Contexts are further complicated by the age/grade level delineation and curricular practices of elementary school settings. In an early elementary environment, PS-ESTs are exposed to learning spaces typified by a wide variety of skills and the absence of subject specialization, which usually means that science receives minimal attention (Milner et al., 2012). The lack of specialization also means that a science-oriented peer group is unlikely and that classroom alignment with science is infrequent (Appleton, 2008). This absence of a science subculture (Baggott La Velle et al., 2004; Gee, 2000) and the subsequent influential affinities associated with the subculture (e.g. focus on inquiry, hands-on science) are in contrast to methods courses that are specifically focused on science content and science teaching expectations designed to encourage the PS-EST's use of them. These differences also mean that PS-ESTs who develop in academic environments legitimated by recognition of or affinity with science-based practices (Gee, 2000; April Luehmann & Tinelli, 2008) are not afforded the same in elementary school settings (Appleton, 2008; Hechter, 2011). For example, instead of participation that stimulates the organization of knowledge and practice based on science content, elementary schools often produce an environment that values other practices (Farland-Smith, 2011); this is a benefit for the development of some facets of teacher identity, but a hindrance, by omission, to the development of science teaching skill.

Methods Coursework

The science methods course is structured around the idea of a teaching cycle (Shulman, 1987) that offers a framework for thinking about the different aspects of successful science teaching. By design, the PS-ESTs are encouraged to develop understandings of what learning goals and objectives should be utilized to define their classroom space. This clarification process occurs in part when the PS-ESTs are challenged to analyze curriculum and through practicum experiences in authentic school environments. By espousing the importance of establishing learning goals and providing exposure to field experiences in local elementary schools, the methods course encourages the development of a figured world (Holland, Skinner, Lachicotte, & Cain, 1998) in the form of a classroom that values content-related practices and outcomes. The PS-ESTs are also encouraged to develop understandings of what constitutes planning and teaching strategies by designing their own lessons around specific content and goals for that content. Through designing and implementing their own lesson plans, PS-ESTs learn to reflect upon and revise their practices by assessing what they are learning and what they have attempted. While PS-ESTs are engaged through classroom discussion and reflective writing on meaningful experiences, the participatory community featured in this study adds the new facet of using social media to interact, making the PS-ESTs' individual thoughts and perceptions public and open to the critique of their peers; this interaction is prompted and done in lieu of asking students to produce reflection papers.

Science Content

Most methods courses cover science content concurrently with modeled pedagogy (Santau, Maerten-Rivera, Bovis & Orend, 2014) with the goal of having PS-ESTs demonstrate improvement on more difficult concepts. While emphasis may vary based on the methods course (e.g. environmental science vs. life science), outcomes are still bound by efforts to improve PS-ESTs' science content knowledge. . Though inconsistencies exist with regards to the inclusion of content highlighted in national standards and in the linkages between course goals, activities, and assignments (Smith & Gess-Newsome, 2004), there is a profound effort to aid development, usually with a specific focus on key conceptualizations (e.g. climate change) (Matkins & Bell, 2007; Hestness, Randy McGinnis, Riedinger, Marbach-Ad, 2011). Trends in methods courses indicate intentional efforts to generate content understanding in PS-ESTs. Learning models couched within methods courses are producing conceptual understandings (Sackes & Trundle, 2014), and though the content area can vary, methods courses are working to develop content knowledge as a separate component of the PS-ESTs repertoire.

Table 2.4

Summary of Literature Illuminating Contextual Influences

Context	Reference
Content	Santau, Maerten-Rivera, Bovis & Orend, 2014; Smith & Gess-Newsome, 2004; Matkins & Bell, 2007; Hestness, Randy McGinnis, Riedinger, Marbach-Ad, 2011
Standards	Gee, 2000; Settlage, et al., 2009; Taubman, 2009; Eick, 2009; Yager, 2005; Quinn, 2011
Cooperating Teachers	Forbes, 2013; Sadler, 2006; Eick, 2009; Luft & Patterson, 2002
Academic Coursework and Space	Kincheloe, McKinley, Lim, & Calabrese Barton, 2006; Hechter, 2011; Sadler, 2006; Wortham 2006; Abd-El-Khalick, F., 2001; Tsai, 2004; Shulman, 1987

Interactions

Within scaffolded settings, three dyadic tensions exist that serve two important functions when considering identity: defining the science teacher's role and fostering development (See Table 2.5). These tensions involve what was previously discussed: individual identity and the structural influences of context and content (Steele, Brew, Rees, & Ibrahim-Khan, 2013). These tensions include various facets of the PS-ESTs' academic cohort and teacher education practices. Content was considered separately from other influences normally included in the broad net of contextual structures because it provided specific emphases for classroom practices and roles.

Individual and Context Interactions

For contexts to be conducive to science teacher identity development for elementary school teachers, it is important for them to include science content and related practices appropriate for elementary-aged learners; these contexts must also enable science teaching (Duffy et al., 2010). Through an overlap of these influences, a context that is rich with such content affinities and discourses populated by individuals who value and desire to teach produces opportunities for development. PS-ESTs with these positive inclinations are exposed to new ideas in the context and because of personal belief about content they feel compelled to integrate what is presented (Grier & Johnston, 2009). Such individuals, when placed in formative environments, develop because of the presence of values for science teaching and learning.

Though potential for this tension between individuals and contexts exists, PS-ESTs who have the aforementioned tendencies are uncommon, as are elementary school contexts with strongly established science education practices (Marbach-Ad & McGinnis, 2008; Meier, 2012). Instead of individual and contextual expectations that encourage development, the PS-ESTs are left to rely on questionable, formative experiences and beliefs produced through their own educational histories. This limitation is briefly assuaged by exposure to authentic science practices in academic coursework, but discontinues, or at least diminishes, upon the PS-ESTs' departure from the academic context (e.g. Patchen & Crawford, 2011; Matkins & Bell, 2007). PS-ESTs do exhibit a willingness to develop practices because of group and contextual affinities in academic contexts (Barab, 2003; Lave & Wenger, 1991), but this willingness is lessened by PS-EST anxiety about science and transition into school environments that limit emphasis on science teaching.

Individual and Science Content Interactions

For the individual/science content tension, of importance is what the PS-EST exhibits when not afforded the structures of scaffolded environments such as the academic classroom.

Theoretically strong or developing teacher identities are exemplified by practices that engage students in science through participation and learning that extends beyond knowledge acquisition and rote memorization. When science teaching ability is present, the individual demonstrates both comprehension of content and the use of appropriate practices because of personal competency (e.g. Levin, et.al. 2009). PS-ESTs do not exhibit such traits, and tend to revert towards knowledge acquisition (e.g. Patchen & Crawford, 2011; Matkins & Bell, 2007) or align their practices with those of the school subculture, minimizing science teaching and learning (e.g. Baggotte La Velle, 2004).

PS-ESTs vacillate between a willing capability during academic classes to hesitancy and the use of what is comfortable in the local classroom or other non-academic learning contexts (Bryan, 2003; Forbes & Davis, 2008; Patchen & Crawford, 2011). The primary reason is that the PS-ESTs' science teaching practices are not based on personal comprehension of science content, but the provisional influences of academic settings (Anderson et al., 2013; Taranto, 2011). The "faux" expertise observed during academic coursework is produced by influences defined by what is salient for success (e.g. good grades) in the methods course. Instead of tendencies to reorient teaching practices to reflect those emulated or utilized during undergraduate work, PS-ESTs practice what they are comfortable with or what is made salient by the expectations of the professional contexts associated with local schools.

That expertise that manifests in academic settings is not authentic is based on the theoretical idea that an individual with expertise will take unfamiliar schema and use their own skill sets to generate a desired learning environment or learning outcome (e.g. Holland. et.al. 1998). PS-ESTs maintain a personal dualism in their practices. On one hand, they adapt to the scaffolding or objective influences found in academic settings, and on the other, they minimize the same practices because the unscaffolded context of a local classroom emphasizes different practices (e.g. Kirschner, Sweller, & Clark, 2006; Mayer, 2004; Salter & Atkins, 2011).

Context and Science Content Interactions

PS-ESTs' ability to engage in authentic scientific practices outside of a stimulating context is challenged because the PS-ESTs are still developing the skill sets necessary for good science teaching (e.g. Matkins & Bell, 2007). Possibilities for change are based on the influence of professional environments infused with strong science content and related practices (Baggott La Velle et al., 2004). Such contexts value the importance of science and this importance is featured in discourses and practices (E.g. AAAS, 1990; 1993; 2012).

Though science content is consistent and valued in academic coursework, elementary educational contexts generally do not have a similar subculture (Baggott La Velle, et al., 2004). This limitation in local school contexts can be overcome when beliefs and practices exist among local school agents that generate a culture that values science. And while recent emphases on STEM have the potential to reformulate local school values regarding science, current elementary school environments fall short (e.g. Meier, 2012, Milner, et.al. 2012). Usually reshaping a school culture involves teachers who are viewed as exemplars of science teaching and can be emulated (Luehmann & Tinelli, 2008). Though exemplars are difference makers for school cultures, they are uncommon in elementary schools. As a result, though the elementary school culture is made up of good, experienced teachers, the likelihood of multiple individuals with strong science backgrounds or teaching experience is unlikely (Baggott La Velle, et al., 2004; Matkins & Bell, 2007).

Table 2.5

Dyadic Tensions: Ideas of Science Teacher Development

Tension	Ideal	Actual	Reference
Individual and Context	-Subject grade level learning to science content -Utilize epistemic science practices -Enable science teaching -Rich with affinities and discourses aligned with the expectations of expert communities -Produces an opportunity for development or reinforcement of science teaching identity -Personal comprehension of content and practice -Adherence to authentic science practices -Allows/leads to the integration of new ideas -Encourage adherence to and the valuation of epistemic science for teaching and learning	-PS-ESTs who have such tendencies are rare as are the required contexts - PS-ESTs do exhibit a willingness to develop group and contextual affinities in academic contexts -Affinity is often diminished by PS-ESTs' limited comprehension of science -Elementary school environments are often defined by a limited emphasis on science	Fairbanks, et al., 2010; Bhattacharyya, et al., 2009; Grier & Johnston, 2009; Marbach-Ad & McGinnis, 2008; Meier, 2012; Barab, 2001; Lave & Wenger, 1991
Individual and Content	-Strong or developing identities use practices that induce student (not PS-EST) participation and learning of science -Comprehension of content -Use of appropriate practices -Competency with science and affiliated practices	-Tendency to revert to pre-academic practices; acquisition-oriented vs. participatory practices - Practices not based on personal comprehension of NOS/epistemic science. -Practices are contextually defined -Reorientation from one context to the next -Practices produced in academic settings are provisional -Practices based on academic salience	Patchen & Crawford, 2011; Bryan, 2003; Forbes & Davis, 2008; Anderson, et al., 2013; Taranto, 2011; Kirschner, Sweller, & Clark, 2006; Mayer, 2004; Salter & Atkins, 2011
Content and Context	-Change resides in the possibility of professional environments with strong science epistemologies -Produce expectations that result in an increased use of	-Epistemic science is consistent and valued in academic coursework -Elementary schools generally do not have a science subculture -Science subculture can be overcome by teachers with	Baggott La Velle, et al., 2004; Luehmann & Tinelli, 2008; Meier, 2012, Milner, et.al. 2012

	epistemic science knowledge and practices	beliefs and practices aligned with epistemic science -Elementary school environments are rarely populated by individuals with strong science teaching practices. -Good, experienced teachers are unlikely to have a science background	

Social Media

Social media is an acknowledged 21st century vehicle for the exchange of information and ideas. In this section of the literature review, social media, specifically blogging, is considered for what it affords within the domain of teacher education. Specifically considered is blogging situated within a science methods course for elementary teachers (See Table 2.7). A survey of the literature is used to illuminate how teacher education can utilize blogging. This survey is then used to distinguish similarities and differences between blogging and normal reflection practices. Also clarified are the affordances of blogging for developing community within a peer cohort and ways that socially-mediated communities are distinguished from a community of practice.

Teacher Education and Social Media

Teacher education programs that utilize social media help PS-ESTs cultivate a network (Hsi, 2007; Luehmann & Tinelli, 2008) that has the potential to aid future development by affording opportunities (Loving, Schroeder, Kang, Shimek, & Herbert, 2007) that extend beyond traditional face-to-face classroom encounters. These are seen as potential support for PS-ESTs because they provide opportunities for reflection and conversation among peers (Killeavy & Moloney, 2010). Research indicates that while PS-ESTs develop understandings in how to teach science in their methods courses, what is learned in their academic environments does not always transfer to their classroom practice (Baggott La Velle et al., 2004; Marbach-Ad & McGinnis, 2008; Meier, 2012; Milner et al., 2011).

PS-ESTs develop skill sets related to how to teach science because of methods course work (Hanuscin, 2013). However, PS-ESTs revert back to what is familiar upon graduation (Hanuscin, 2013; Matkins & Bell, 2007; Patchen & Crawford, 2011). Though some practices are useful, PS-EST reversion to what they have previously observed (Boyd, Jones, Justice, & Anderson, 2013; Lortie, 1975) is often at the expense of effective science teaching (Steele et al., 2013). Addressing this challenge requires developing PS-ESTs competency sufficiently to allow transfer of what they have learned in methods courses to the context of their future classroom and school. This transfer of concepts is a long-term goal of education and is oriented around the desire to help PS-ESTs develop conceptions of science and science teaching appropriate for maximizing student learning (Kuhn et al., 2000; Leach & Scott, 2008; Vosniadou, 2008).

Social media has the potential to enhance development and encourage development beyond undergraduate coursework studies (Anderson et al., 2013; Killeavy & Moloney, 2010; Lankshear & Knobel, 2006; Miranda & Damico, 2013; Watters, 2000). Researchers (e.g. Yang, 2009; Nardi et al., 2004) cite several attributes that contribute to the effectiveness of blogs as tools of reflection and conversation. First, blog entries appear in reverse chronological order and are accessible from a single site, making it easier for users to read prior entries and discern development over time (Nardi et al., 2004; Yang & Chang, 2012). Additionally, bloggers can enhance posts through tools such as embedded hyperlinks, graphics, videos, and comments, which may facilitate the evaluation and problematizing of practice (de Moor & Efimova, 2004).

Luehmann (2008, 2011) noted that the affordances of social media (e.g. blogging) can be used to support the development of new types of professional teacher identities. Blogs generate awareness through the sharing of personal educational autobiographies (Duffy et al., 2010) and the engagement of peers through critical inquiry-based reflection and in community-based interactions (Ohana, 2004). Additionally, blogs generate awareness through the study of practice that is connected to, yet removed from, content-specific daily practice (Luehmann & Tinelli, 2008; Luehmann & Borasi, 2011); consideration and integration of an expert voice (Anderson et al., 2013); and sustained engagement in thoughtful, intentional, and professional practices (Luehmann & Borasi, 2011). These opportunities occur through self-reflection, the study of learned lessons, and engagement with peers.

Social media enables reflections that are narratives about shared academic or historical experiences (Davis, Beyer, Forbes, & Stevens, 2011; Duffy et al., 2010; Hanuscin, 2013). These reflections and conversations represent a new professional teacher identity because PS-ESTs are engaged in role-specific discourses (Gee, 2005) beyond the context in which they would normally occur (Luehmann, 2008, 2011). This reflection illuminates what is forming or changing (Hilton, 2010; Sutherland et al., 2010) because the participation in reflection is a type of discourse (Gee, 2005) that allows for self and affinity group recognition. For PS-ESTs, this reflection and resulting conversations are a beneficial artifact of events that include field experiences, observations of other teachers, autobiographical and biographical accounts, and various pedagogical practices (Luehmann & Tinelli, 2008; Luehmann & Borasi, 2011; Sutherland et al., 2010). PS-ESTs develop skills through observations, critical self-reflection, and conversations with others (Luehmann & Tinelli, 2008; Luehmann & Borasi, 2011; Sutherland et al., 2010). These critical reflections and conversations can be integrated into future practices (Burke, 2007; Burke & Stets, 2009; Forssell, 2009), making input from social media a unique and new component of a participatory community.

Blogs generate beneficial conversations because they are created by individuals who are operating with specific perceptions about current and future roles (Burke & Stets, 2009). As individual PS-ESTs share perspectives comprised of practices and beliefs specifically associated with how to teach science, they create opportunity for interaction and feedback. In turn, this feedback generates the potential for modification of behavior that is aligned with the social situation or role being encouraged, that of a science teacher (Burke & Stets, 2009).

Reflection vs. Blogging. Reflection is a common practice in teacher education (Harland & Wondra, 2011) that routinely challenges PS-ESTs (Yang & Chang, 2012). What differentiates blogging is the supposition that it is reflection and conversation (Killeavy & Moloney, 2010; Yang & Chang, 2012). On an individual level, this enhanced reflection is a window into the thought processes and discourse utilized by PS-ESTs as well as their personal values for science content and professional expectations (Anderson et al., 2013). On a corporate level, these posts become a form of contextual input and a standard bearer for the participatory community where knowledge derived from common experiences and the reactions of others is shared (Burke & Stets, 2009). Whether an individual self-reflection or authored to an audience, blogs are presumed to present unique, rich opportunities for development in PS-EST thinking (de Moor & Efimova, 2004; Hramiak et al., 2009; Killeavy & Moloney, 2010; Yang & Chang, 2012). These reflections are based on perceptions of teaching and experience that are influenced by the personal beliefs of the PS-ESTs. The personal beliefs of the PS-ESTs are influenced by the communities (e.g., academic during coursework, localized professional communities during field experiences) in which they participate.

Community and Social Media

Definitions of community vary, but it is often defined as a persistent, sustained, social network sharing an overlapping knowledge base and a focus on common practices or mutual enterprise (Barab, MaKinster, & Sheckler, 2004). From an educational standpoint, a community's importance lies in its ability to enhance learning in ways that individual practices do not. This includes an ability to induce participation of members, the integration of social and cognitive processes geared toward the development of skills associated with specific roles, and the presence of social practices that encourage interactions among members (Lave & Wenger, 1991; Wenger, 1998a).

For academic cohorts, these communities bear some resemblance to a community of practice (CoP), with several noted distinctions. Communities of practice (CoP) are prolonged, established, perpetuated by apprenticeship, and characterized by the deliberate efforts of mentoring experts to evolve the thinking of novice members (Barab et al., 2009; Lave & Wenger, 1991). A participatory community exists for a limited time, dissolving once members graduate from the unique form of membership afforded by them (Wall, et.al, 2014). This ending is the result of one of the community's goals to ensure the PS-ESTs completion of coursework designed for induction into the professional teaching community (Marbach-Ad & McGinnis, 2008; Taranto, 2011).

Though their existence is limited chronologically, participatory communities manage to place value upon participatory learning, conceptual change, and understanding of specific skills associated with established objectives (Akerson, Cullen, & Hanson, 2009; Sewell et al., 2013). The expectations for science-related pedagogical skill and content knowledge for the learning and development of community members are similar to those associated with a CoP. However, a participatory community is not a CoP because its brevity hinders the endurance of practices associated with a CoP (Barab et al., 2009). Specifically, where a CoP values the role of mentor-mentee relations, the influence of a participatory community is generated through communications that occur among new peer members. Where a CoP places value on the development of individuals through apprenticeship that is afforded by the presence of expert members, history, and culture (Lave & Wenger, 1991), a participatory community operates by valuing the influences of peers who, due to the short-term nature of the community, will not be present to allow their developing skill sets to influence a second generation of learners.

The primary influences of participatory communities are facilitated through asynchronous posts involving member reflections on experiences generated by specific activities, such as those that occur in blogging in academic spaces. A variety of factors influence these reflections, including the unique personal histories of the PS-ESTs (Farland-Smith, 2011; Ganchorre & Tomanek, 2012; Rodgers & Scott, 2008) and the academic willingness of community members to embrace development. For the participatory community, social media aids development by allowing community members access to others (Schlager et al., 2009). The unique affordances of these digital structures allows the influence of the academic classroom (Clarke & Kinne, 2012; Thomas, 2011) to be expanded, (Galman, 2009) though whether this occurs is determined by the PS-ESTs' use of requisite skills, knowledge, and evidences of science teaching (Barab et al., 2009).

In the twenty-first century, the participatory community structure allows for extending development in several ways. First, the community is linked to the academic subculture of coursework (Hechter, 2011; Lotter et al., 2009) that produces a strong science-oriented epistemological environment (Bhattacharyya et al., 2009; Zemba-Saul et al., 2000). Communications within these participatory communities help embody and model appropriate practices for PS-ESTs. Second, the efforts of the PS-EST to generate provisional influences are illuminated and enhanced by the digital social platforms such as blogging (Settlage et al., 2009). Finally, development made possible by academic coursework is enhanced by PS-EST observations and adaptations to contextualized beliefs expressed through shared reflections and comments (Harland & Wondra, 2011; Hramiak et al., 2009) (see Table 2.6).

Table 2.6

Summary of Literature dealing with Social Media and Community

	Tenet	Trait	Reference
Group Processes	Social media and community are mutually involved	-Develop social network -Technology enhances both learning and community development -Technology allows for access to information, professional tools, and concrete, lively feedback -Communities are a product of conflict between individual identities and experiences in teacher contexts -Enhanced and encumbered by technology as new expertise arises and is distributed -Involve trust formation	Killeavy & Moloney, 2010; Lankshear & Knobel, 2006; Anderson, et al., 2013; Yang & Chang, 2012; Sawmiller, 2010; Luehmann & Borasi, 2011; Clyde, 2005; Schlager et al, 2009; Finn et al, 2008; Galman, 2009; Young and Tseng, 2008.
	Community involves group processes	-Communication -Shared goals -Individuals share and develop knowledge, beliefs, values, history, and experiences -Focused on common practice and/or mutual experiences -Involve social and cognitive processes -Encourage interactions among members	Barab, Barnett, & Squire, 2009; Barab 2003; Schlager, Farooq, Fusco, Schank, & Dwyer, 2009; Finn, Gomez, Griesdorn, & Sherin, 2008; Lankshear & Knobel, 2006; Taylor, 2006; Galman 2009; Young & Tseng, 2008; Worchel & Coutant, 2003;
	Community Involves Individuation	-Personal goals and responsibilities -Transitions in self-efficacy -Development intended to aid induction	Hechter, 2011; Steele, et al., 2013; Aikenhead, 2001; E. Kang, Bianchini, & Kelly, 2013; Gunning & Mensah, 2011; Settlage, et al., 2009; Velthuis, et al., 2013; Yoon, et al., 2006; Taranto, 2011
Technol ogy and	Affordances of Blogging/Digital Media	-Enhances development -Allows members access to information, professional tools, and concrete, lively feedback -Interactions involving technological communication are becoming the norm. -Allow for conflict of opposing thoughts.	Gomez, Sherin, Griesdorn, & Finn, 2008; Schlager, et al., 2009; Wenger, 1998; Gee, 2000; Luehmann & Borasi, 2011; Luehmann & Tinelli, 2008; Sutherland, et al., 2010

		-Allows for a level of self-reflection and reflection on the practices of others -PS-ESTs are engaged in role-specific discourses -Opportunities for critical self-reflection or reflection	
	Affordances of a Peer Community	-Enhance learning intended to transfer from the academic to the professional context -Consists of an academic subculture governed by institutional expectations, -Peer interactions that lead to group identities -Individuation within the group -Common, historical or current experiences mutually shared -Involves engaged in attempt to develop content knowledge and pedagogical practices -Self-recognition or recognition by others that development is possible -Perceptions are expressed with peers in a manner that enhances development -Generate a variety of interactions significant to identity development -Success is contingent upon the development of requisite skills and knowledge -evidences for this are present in the unique reflections of members of the community on their experiences and the experiences of others	E. Kang, et al., 2013; Wall, 2013; Appleton, 2008; Koehler, 2011; Nilsson & Loughran, 2011; Bhattacharyya, et al., 2009; Yoon, et al., 2006; Czerniak, et al., 1999; Hubbard & Abell, 2005; Farland-Smith, 2011; Kaptelinin & Nardi, 2006; Nardi, Schiano, Gumbrecht, & Swartz, 2004; Schlager, et al., 2009

Summary of Social Media Affordances for Teacher Education

There are several conclusions that can be drawn from the research presented in this literature (See Table 2.7). First, membership in a community affords some benefit to members (Worchel & Coutant, 2003). Second, given the importance of variables associated with identity and interactions involving these variables, a logical location for these interactions is in a participatory community that shares common goals (e.g. Lave & Wenger, 1998; Wall, et.al. 2012). This community involves various group processes and can be enhanced by blogging. Blogs can augment existing opportunities and generate new ones for development that include critical reflection, extension of the academic classroom, and access to meaningful feedback and reflection. Third, the evaluation of blogging within the context of a community is worthwhile because of the benefit to development generated by individual and community-based narratives (Worchel & Coutant, 2003; Tindale, et.al. 2003). Fourth, a focus on the affordances and use of blogging within communities has the potential to endow teacher educators with the opportunity to reconsider how they integrate technology-driven and/or community-based practices in domain-rich fields such as science education. Coupled with the advent of digital media and its use to extend the classroom, research that considers the role of community is invaluable for twenty-first century teacher education (Hilton, 2010).

Table 2.7

Affordances of Social Media and Community in Teacher Education

	Social Media and Community	References
Affordances	-Help the PS-ESTs to form a network -Potentially aids future development by affording opportunities -Some reflective practice and group dialogue -Not universally accepted -Perceived to offer some benefit -Extends the academic classroom and generates beneficial practices for PS-ESTs -Cite several attributes that contribute to the effectiveness of blogs as tools of reflection. -Entries appear in reverse chronological order -Accessible from a single site -Discern development over time -Bloggers can enhance posts -Available tools include embedded hyperlinks, graphics, videos, and comments -May facilitate the evaluation and problematizing of practice -Creation of opportunities for awareness -Illuminates what is forming or changing in the PS-EST	Hsi, 2007; Luehmann & Tinelli, 2008; Loving, Schroeder, Kang, Shimek, & Herbert, 2007; Killeavy & Moloney, 2010; Harland & Wondra, 2011; Killeavy & Moloney, 2010; Watters, 2000; Yang, 2009; Nardi et al., 2004; Nardi, et al., 2004; Yang & Chang, 2012; de Moor & Efimova, 2004; Luehmann & Borasi, 2011; Hilton, 2010; Sutherland, et al., 2010
	-Differs from a CoP -Time it exists limits or hinders the possibility of practices common to a CoP -Exist for a limited time -Dissolve once members graduate from the unique form of membership afforded by them -Cease upon induction into professional service -Value participatory learning, conceptual change and understanding of specific skills -Skills associated with established goals -Primary influences occur through asynchronous posts involving members reflections upon experiences -Reflections influenced by member's unique personal histories -Allow access to others -Produce a distinct, epistemological environment -Opportunity to observe and adapt to contextualized beliefs -Integrated and embodied in the PS-ESTs' practices and shared with others	Sasha Barab, et al., 2009; Lave & Wenger, 1991; Marbach-Ad & McGinnis, 2008; Taranto, 2011; Galman, 2009; Farland-Smith, 2011; Ganchorre & Tomanek, 2012; Rodgers & Scott, 2008; Schlager, et al., 2009; Bhattacharyya, et al., 2009; Zemba-Saul, et al., 2000; Harland & Wondra, 2011; Hramiak, et al., 2009

Chapter Two Summary

There are a number of studies focused on any one of the factors introduced in this review of the literature (e.g. science teacher education, contexts, identity, or social media), yet there are few, if any, studies that take into consideration all simultaneously. Technology-mediated science teacher education research, specific considering the role of identity, contextual influences, and interactions is uncommon. This study adds to this narrow literature base by examining PS-EST identity development in a unique, technology enhanced, participatory community.

The consideration of the literature for this study was based on specific ideas. The first was focused on the importance of individuality and context in shaping identity. For individuality, the role of personal beliefs and experiences for pre-service teachers were highlighted. Whether a component of their educational history or contemporary education, experiences were shown to be a strong influence on perceptions of science teaching. Coupled with these experiences were beliefs which often served as a lens for how PS-ESTs might process what they experienced. These beliefs could lead to contrarian positionalities or the acceptance of a common practice. A second focus was an examination of literature associated with relevant contexts that emphasized the importance of objective influences including the scaffolding of academic courses, local elementary schools, and those with important social roles (e.g. cooperating teachers, administrators). These influences revealed the various expectations established by contexts associated with the science teaching role. Within the construct of context was the unique influence of science content that governed approaches to learning, including setting learning goals and expectations for what learning outcomes were acceptable.

Understanding PS-EST efforts to reconcile their beliefs with inputs associated with science teaching contexts requires research that focuses on the discourse of PS-ESTs, making social media, a third focus of the literature review, an important tool for research. PS-ESTs' efforts to develop science teaching knowledge can illuminate various tensions important to development, or at least awareness of the science teaching role, especially practices associated with current teacher education practices. The affordances of social media make observation and analysis of these mental constructs possible. For now, there is not an explicit focus on how the identity of the PS-ESTs, their contexts, and interactions that occur with teacher education contexts impact PS-ESTs' development as science teachers. However, because PS-EST teaching identities are shaped by their contexts (Appleton & Kindt, 2002; Schussler et al., 2010), research is needed about what PS-ESTs are saying or thinking upon exposure to these contexts. This research seeks to address current gaps associated with PS-EST teaching identities and their contexts by using social media in teacher education: The goal being to use blogging to further understand the development of PS-ESTs.

CHAPTER 3

Methodology

This chapter discusses the research methods that were employed in the study and the underlying epistemological frameworks that informed these methods. The use of perceptual control theory and constructivist grounded theory in data collection, coding, and analysis processes are explained. Additionally, the discussion is supplemented by descriptions of the research study context. The chapter concludes with a specific description of research strategies used to explore each research question.

Purpose of Study

Through careful investigation this dissertation hopes to offer two primary insights about individual identities and the interactions that occur in association with science teaching and learning. While the data are generated through blogs and comments posted in a semi-public forum generated by the use of social media, the intent of the project is to look at what the data reveal about mediating or transformative influences on the PS-ESTs science teaching identities. Ideally, what is illuminated through blogging can produce insights on how teaching identity manifests as well as PS-ESTs' awareness of how to teach science. This study is not intended as an evaluation of social media. Of importance for this dissertation are the interactions that occur among PS-ESTs on a one-to-one basis, the influences of group dynamics associated with the PS-ESTs' cohorts, and the structural influences associated with the various contexts that the PS-ESTs occupy during their enrollment in methods courses. The study is guided by the questions that are presented in Chapter One:

1. What is learned about the identity of PS-ESTs authored through social media?
    a. What is learned about PS-EST beliefs?
    b. What is learned about the experiences of PS-ESTs?
2. What contextual influences are acknowledged by PS-ESTs? How do PS-ESTs process and utilize these influences?
3. What interactions are occurring? What roles do these interactions play in the development of PS-ESTs?

Research Design

A qualitative study was utilized and designed (see Figure 3.3) because the data consisted of a repository of student comments and feedback from an undergraduate senior methods courses for education majors. A qualitative approach utilizes an *emic* approach that emphasizes how meaning is constructed from the experiences of the participants (Denzin & Lincoln, 2000). This *emic* quality aids the interpretation of PS-EST perspectives that represent lived experiences (Denzin, 1978; Denzin & Lincoln, 2005; Maulucci, 2010), and enables the qualitative investigation of how the participants think and how they perceive their context, derive meaning, and imagine and explain things (Allchin, 2011). Such findings can be used to understand the inherent complexity and variability of human behavior and experience associated with the PS-ESTs' development as science teachers (Savin-Baden & Major, 2013).

Even though generalizability is not an aim of qualitative research, transferability is a concern. Transferability refers to the similarities between the research context and other contexts (Mertens, 2009). Several variables ensure that some level of transmission from context to context is possible. While context and culture are acknowledged limitations (Cole, 1996), the PS-ESTs who are part of the study are demographically representative of elementary education majors throughout the nation (S. Smith, 2014). Also, assertions can be extrapolated because of the human condition, the commonality of field experiences in teacher education programs, and like-minded goals associated with teacher preparation. Besides these commonalities, the *etic* perspective (Denzin & Lincoln, 2000), a detached view that may differ from the research participants' perspectives, also supports transferability. Reduction of the data to thematic ideas beneficial to science teacher education utilize historically reliable knowledge and practices for analysis of the PS-ESTs' activity (Pellegrino et al., 2001). By utilizing established standards, analysis is shifted from local observations, categories, explanations, and interpretations (Solano-Flores & Nelson-Barber, 2001) to those of the researcher who utilizes decontextualized knowledge and expertise. Transferability is also aided in other ways in the study.

Transferability is facilitated by the inclusion of rich descriptions of the context; these descriptions add meaning to what is presented and help the reader to judge if the research context is similar to other contexts. Additionally, these descriptions bound the findings to specific ideas associated with teacher education and, more specifically, science teacher education. The rich descriptions also address another quality criterion of qualitative research, confirmability. Confirmability pertains to the extent the links between the data, data analysis, and interpretations are evident (Mertens, 2009). The intent of the rich descriptions is to allow the reader to make connections between assertions generated from data analysis and other phenomena associated with teacher education (e.g. research studies, personal experiences). Lastly, measures were taken in the study to address credibility, the degree to which the research findings adequately represent the participants' views (Mertens, 2009).

The described phenomena are legitimated because they embody the participants' own perceptions, which imbue the data with credibility. Data analysis and reduction are based on the personally authored words of the participants. While these reflections and conversations presented through the PS-EST posts on the blog are based on shared experiences (e.g. academic classroom, field observations), the emphasis is not on the experience itself but what the PS-EST perceives and chooses to report. These reflections and conversations inherently contain truths relative to the PS-ESTs; they also have an authenticity and meaning generated through socially developed experiences (Savin-Baden & Major, 2013).

Researcher's Positionality

This research involved two primary recognitions. One, the role of context was juxtaposed with the role of content. Second, my own masculine perspectives as a researcher, a "he presence," contrasted with the role of feminine discourses that are explicit and implicit in the field of elementary education that is dominated by female practitioners. Both of these variables shaped the positionality and viewpoints of the researcher during data analysis.

The role of context contrasted with content led the researcher to examine the purposes of education centered on the use of constructivist approaches to learning (Kirschner, Sweller, & Clark, 2006). These attempts at resolving dissonance were based in a perception that learning requires the acquisition of content knowledge and a receptivity of individuals to this acquisition. Dissonance occurred because rather than a focus upon commonly utilized constructivist approaches that value learning as an exploration and sociocultural activity involving minimal guidance (Barab, 2001; Leach & Scott, 2008), learning was perceived, by this dissertator, to be bound by content knowledge roles. Given the fact that PS-ESTs are developing as professional pedagogues and are generally classified as novices who are dependent upon objective influences (e.g. Kuhn, 2000), a focus of experts on how PS-ESTs learn how to teach science was deemed vital by the researcher. The researcher's rationale was that guidance from acknowledged experts was advantageous, important, and necessary for the PS-ESTs' development, only becoming less so when the PS-ESTs developed a sufficient level of PCK that enabled the production of "internal" guidance. Knowing that the PS-ESTs had minimal knowledge about how to teach science, this research was conducted with two slightly contradictory understandings. One was recognition that constructivist approaches were prevalent in methods courses, and two, that the PS-ESTs also required some level of supervision to produce meaningful learning outcomes beneficial for long-term practices.

The second, distinct positional recognition was that this dissertation involved a male researcher investigating a field of study historically occupied by females. Science education was also viewed as such, having a historical trajectory (Bourdieu & Passeron, 2000) where feminine qualities such as connectedness, emotion, cooperation, subjectivity, and communality were not prevalent or valued (Wylie, Potter, & Bauchspies, 2012). This recognition was important because the institutions of science traditionally exclude women and issues of concern to women and sex/gender minorities. Given the presence of gender-normative stereotypes in the field of science and that scientific authority often rationalizes social roles and institutions that feminists question, this dissertation research is conducted with an awareness of normative stereotypes.

Masculine positionality produced its challenge during the data analysis process. This dissertator frequently had to avoid in the data analysis the eisegesis of the dominant norm in science. For example, historically science is populated by males and has a strong cultural history that supports certain values for discourse and practice. In reading the data and seeking to truly understand what it was saying, it was necessary to monitor the researcher's personal evaluation of content in the PS-ESTs' posts and comments. The PS-ESTs frequently spoke of student engagement, excitement, or fun—a finding of considerable importance when considering the integration of science teaching in elementary classrooms. Instead of seeing themes such as this as potential epiphanies for teacher education practices, the researcher ignored their role as a consequence of the centrality of content in his perspective until the latter stages of data analysis.

The Research Setting

Participants, all designated by pseudonyms, in this study were senior elementary education majors. As seniors, participants were in their second year of the program, having already completed a year of coursework in a cohort. As a coursework requirement each student generated blogs that were available for selection in this study. Students' blog entries were examined from a two-year period of the methods courses. The participants reflect the students enrolled in teacher education programs throughout the United States, who are predominantly white, middle class women; these students have a variety of concentrations in addition to elementary education, including a double content focus on either English/Language Arts and Social Studies or Math and Science. During the fall semester of the senior year, participants take methods courses in literacy, science, and mathematics. In conjunction with fall coursework, participants have a practicum experience one day a week within their student teaching placement. In the spring, they student teach at local schools that have established relationships with the university through the teacher education program.

Methods Course

The science methods course is structured around the idea of a teaching cycle (Shulman, 1987) that offers a framework for thinking about the different aspects of successful science teaching. By design, the PS-ESTs are encouraged to develop understanding of what learning goals and objectives should be utilized to define their classroom space. This clarification process occurs in part when the PS-ESTs are challenged to analyze curriculum and through practicum experiences in authentic school environments. By espousing the importance of establishing learning goals and providing exposure to field experiences in local elementary schools, the methods course encourages the development of a classroom that values content-related practices and outcomes (Holland et al., 1998). The PS-ESTs are also encouraged to develop understandings of what constitutes planning and teaching strategies by designing their own lessons around specific content and goals for that content. Through designing and implementing their own lesson plans the PS-ESTs learn to reflect upon and revise their practices by assessing what they are learning and what they have attempted. While PS-ESTs are engaged through classroom discussion and reflective writing on meaningful experiences, the participatory community adds the new facet of using social media to interact, making the PS-ESTs' individual thoughts and perceptions public and open to the critique of their peers; this interaction is prompted and done in lieu of asking students to produce reflection papers.

Blogging

Blogs were seen as a new part of the activity of the methods course, initially pushing the PS-ESTs through required responses to specific experiences and the posts of their peers. By challenging the PS-ESTs to reflect upon methods course experiences enmeshed with a rich, historical culture for science teaching (See Appendix: Class Assignments & Blog Prompts), the blogs extended the influence of the methods course. All students were required to blog regularly in their courses and practicum experiences (See Table 3.1). Each student was required to post nine different blogs over the course of the fall semester. Six of the blogs were written to prompt responses and reflections on science teaching or field experiences associated with science while three of the blog prompts were designed to encompass a broader array of content areas (e.g. literacy, math, etc.). For each blogging assignment, the PS-ESTs were also required to respond to the blogs of two different individuals within the cohort. No other stipulation was made and so the PS-ESTs could comment on the same blogs each week or choose different blogs. The importance of blogs was the personal narratives they contained. Each post and comment illuminated individual perspectives on practices and beliefs specifically associated with science teaching and learning. Objective influences such as contextual agents or schools also produced reflections that illuminated the roles of the environments that the PS-ESTs occupied.

While prompts (See Appendix: Blog Prompts) were used to govern PS-EST inputs, they were generally encouraged to compose entries topical to courses or field experiences. The established due dates and prompts were synchronized with course materials and practicum experiences, yet were designed to minimize student tendencies towards "performance," allowing the PS-ESTs a wide degree of latitude with regards to style and content. On average, each participant had thirty-five to forty separate blog entries that included their response to an established prompt and required comments that were received from other community members. PS-ESTs were also encouraged to voluntarily complete blog entries that were not a specific response to prompted course expectations, but no voluntary posts were made.

Table 3.1

Blog Entry Prompts

Entry #	Entry Description/Prompt for Reflection
Blog Entry #1: **Science Autobiography**	We all bring preconceived ideas and beliefs about teaching to the classroom. Teachers tend to teach as they were taught. The first step in becoming an enthusiastic and skilled teacher of science is to reflect upon the experiences that have shaped your current ideas about science. This will set the stage for the new perspectives offered by this course. A science autobiography is an essay in which you describe your personal experiences, both in and outside of school, and then analyze how those experiences have shaped the way in which you define and view science. First, relate your earliest memories of science and your feelings about them. Why do these experiences stand out and not others? If you don't remember much, speculate why. Continue with your experiences up to the present--be sure to include experiences both in and outside of school. Don't spend too much time retelling instead; concentrate on how you felt about the experiences. As a guide you should address in some way the following the questions: What do you think constitutes science? What do you remember from your own elementary experiences about science? What are your perceptions of science in elementary schools today? What do you think the foci for science should be in elementary school? Next, after you have described your experiences, reread them for analysis. What are the general characteristics of your positive experiences? Negative experiences? Be as candid as possible in responding. What trends do you notice? Finally, give your definition of science. Be sure to explain how your experiences have shaped this.
Blog Entry #2: Reflect on the reading	Chapter 2 of Ready, Set, Science and the AAAS article on the Trouble with Textbooks. What were your impressions? How does science inquiry relate to your own previous science experiences that you talked about in Blog Entry #1?
Blog Entry #3: **Experiential Reflection**	Reflect on your experiences working with the fourth grade students on the Magnet Activity. What conceptions did the students bring to the activity? What surprised you about their thinking on the Page Keeley Exercise? What worked in the activity? What didn't work? What will you do differently next time?
Blog Entry #4: **Hypothetical Reflection**	What would you do? During a school board meeting to discuss the elementary science program, a board member suggests, "While science is important, it should not be emphasized at the elementary level, since the children need to learn reading, math and writing during these formative years. Science, after all, requires memorization of rather extensive amounts of factual knowledge, which should be saved for the middle and high school years. It has little to offer developing minds of elementary school students." For this reason, he argues, minimal time should be allotted to elementary science education. As an elementary teacher at the meeting, you are asked to give your opinion on the

	matter. How would you respond to this school board member's suggestion? Why?
Blog Entry #5 **Curriculum Adaptation**	How might you use elements of UDL in your classroom? Do you see these in the classroom in which you are currently working? How might they be incorporated?
Blog Entry #6: **Experiential Reflection**	Reflect on your experiences in working with the fourth graders a second time. What was different from your first experience? What would you do differently in third visit? How might you begin to assess students' conceptual change and understanding of magnets?
Blog Entry # 7: **Hypothetical Reflection**	Use the curriculum from your curriculum evaluation as the reference for the following: It is the spring and you are beginning to interview for teaching positions! Before being interviewed, you review the science curriculum and it happens to be the curriculum you evaluated in your methods course. You notice in the sample that they provided you that at the end of the activities there is a side heading titled "Connections, " which suggests how to relate the specific activity to other content areas. During the interview, the principal tells you, "We are so excited about our new science curriculum. It is really interdisciplinary. I think you had a chance to look it over. What do you think of it?" How would you respond? Additionally, the principal was curious about how science might look in your classroom. How would you describe it to them? How is this similar to or different from what you have seen in your different placements?
Blog Entry #8 **Using Technology**	Create a SAM on a science topic you would use with your students to explain a specific concept. Embed it on your blog. How could this be used as a formative assessment for your students? Reflect on how technology can be utilized to engage students. What is your reaction to James Gee? How could you potentially use these technologies in your own teaching?
Blog Entry # 9 **Experiential Reflection**	Reflect on your experiences working with the fourth/fifth grade students - What was different from your experiences with the second graders? What worked? What did not work? If you were to go back and repeat this, what would you do differently?

Data Sources

A point of interest for this study is what activity in methods courses illuminates about the identity of PS-ESTs. The goal is to explore, through the use of blogging, the identities of undergraduates as they go through courses and experiences designed to prepare them for both science teaching at the elementary grade level and professional licensure. The data for this project are explained in the sections that will follow. An effort is made to explain where data samples came from, how the data were used to answer the research questions, and how analysis unfolded over the course of the project.

Data Selection

The data for this project were generated from a large project initially designed to integrate blogging as a practice throughout all methods courses. The data existed prior to the genesis of the research questions proposed for this dissertation. While engaged and active in course instruction, interaction with the PS-ESTs was limited to face-to-face encounters. To answer the questions, this pre-existent data set was sampled from multiple blog posts that reflected the perspectives of the PS-ESTs participating in the blogging project (Lincoln & Guba, 1985). The data included the content of student blogs, multimedia posts, and student comments on initial blog posts. These sources, further explained below, correlate to the research questions in Table 3.2. Each blog, along with subsequent comments, was viewed as an individual case.

Table 3.2

Questions and Data Sources

Research Question	**Method**	**Data Obtained**
What is learned about the identity of PS-ESTs authored through social media? What is learned about PS-EST beliefs? What is learned about the experiences of PS-ESTs?	Blog Prompts	**Blog Posts** **Multimedia posts**
What contextual influences are acknowledged by PS-ESTs? How do PS-ESTs process and utilize these influences?	Blog Prompts	**Blog posts** **Comments**

What interactions are occurring? What roles do these interactions play in the development of PS-ESTs?	Blog Prompts	**Blog posts** **Comments**

Blogs were collected from two different cohorts, PS-EST One and PS-EST Two. The first cohort contained fifty-eight students and the second contained thirty-three. Individuals from each cohort were assigned a number, beginning with one. From all blogs, four were randomly chosen for initial coding. Upon completion of the sample coding, a group of ten blogs was randomly selected from each cohort (Creswell, 2008); the total number of blogs was 24, four sample and ten from each cohort. Instead of using numbers in a hat or other similar methodologies, a statistical program, Research Randomizer, was utilized to generate two sets of ten numbers. Random sampling was done to ensure that members of each respective cohort had an equal probability of being chosen. Through random sampling an unbiased representation of members of each cohort group was produced.

Perceptual Control Theory

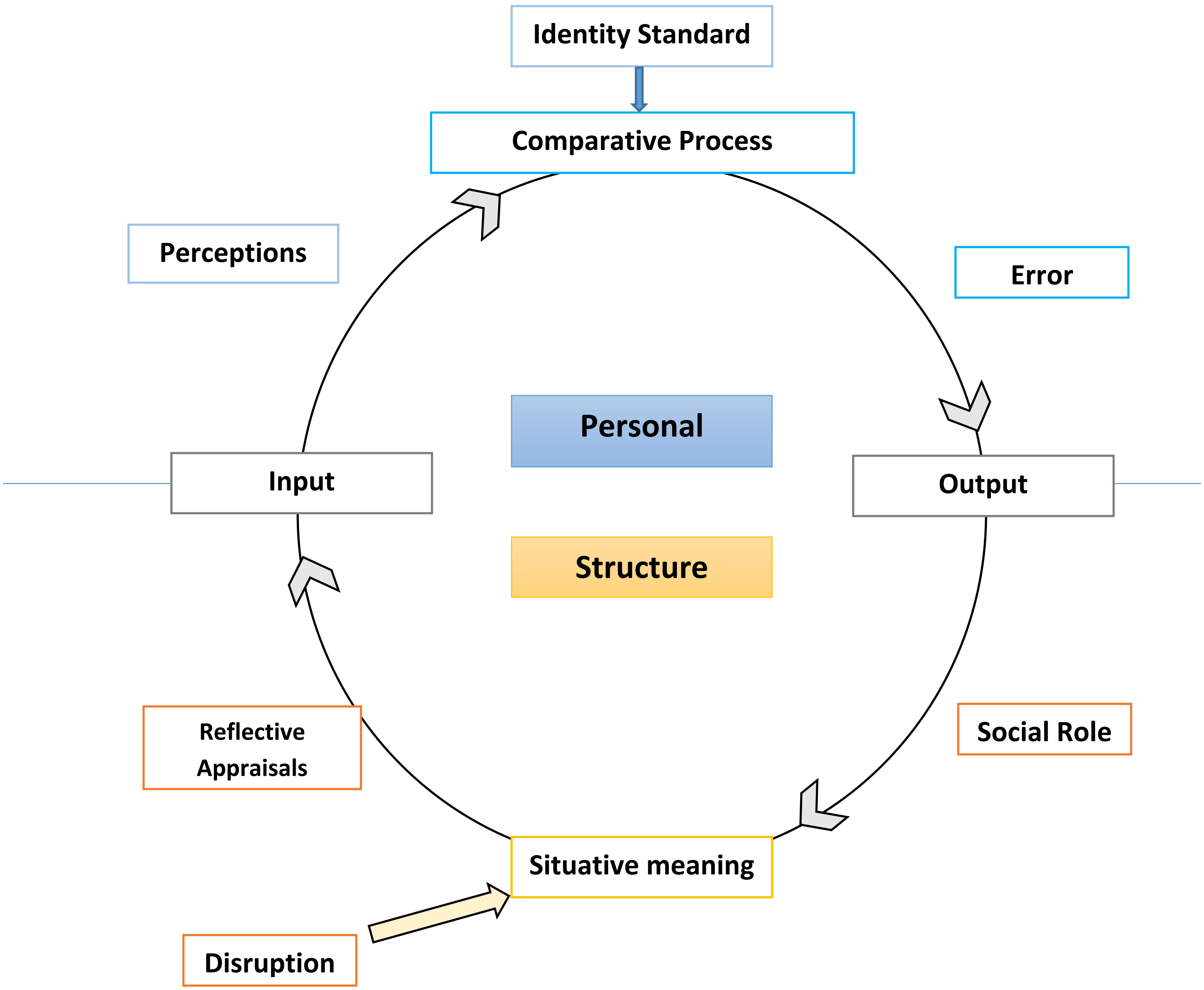
Perceptual control theory (PCT) was posited by Dag Forsell and William Powers for the purposes of understanding what influenced development associated with specific roles, individual-contextual relationships, and inputs beneficial to improvement. PCT postulated that identity relies upon two conditions: 1) the internal dynamics of individuals that operate within specific roles; and 2) the integration of contextual inputs as the individual enacts a perceived role within a context (Forssell, 2009). For elementary PS-ESTs learning science methods, perceptual control theory was useful because the PS-ESTs' teaching identity was derived from the personal value of science, varied contextual inputs derived from self, others, and appropriate contexts, and actions that were defined by common meanings (Burke & Stets, 2009).

The use of perceptual control theory included a feedback loop (Figure 3.1) consisting of an identity standard, perceptual input, a comparison process, and outputs. Personal inputs and the context produced this loop with each component of it important for learning about the PS-ESTs' teaching identities. The first component, the identity standard, represented the beliefs, perceptions, and expectations of the individual. The second component, perceptual input, represented self-reported feedback or inputs received from the context. The third component, the comparison process, represented self-reporting on disruptions associated with the inputs generated within the cohort and its relevant contexts; and the fourth component, output, represented changes to practice or beliefs associated with the specific role of science teaching that were based on the evaluation of perceptual inputs.

One component of the feedback loop, the comparison process, was not explicitly acknowledged by the PS-ESTs, but chronological structure of the blogs, allowed for observations of potential shifts in thinking or an increased awareness of practices associated effective ways to teach science. How the PS-ESTs evaluated their practices constituted a comparison of their current standards with perceptual inputs leading to output that constituted the final component of the feedback loop. Output could be a synchronous adjustment in practice, or a reflection on acceptance, revision, or rejection of a contemporary practice for future use or a shift in thinking about what it meant to be a science teacher. The results of the feedback loop were observed as the PS-EST self-reported modified behavior to align with the social situation (Burke & Stets, 2009); with the hope that any modification reflected an effort to continue to use acceptable science teaching practices or the affirmation of practices associated with an established identity. One dynamic that emerged from the data could not be framed by PCT. The framing “developmental dyad” was created to capture this dynamic.

Developmental Dyads. The study initially focused on the individual PS-ESTs and their interactions with each other. This focus did not allow for the unique contextual interactions indicated in the data. As the PS-ESTS reflected on their experiences or observations, they incorporated components of different identity dyads (e.g., individual and content, content and context). This shift encompassed a new focus on unique contextual interactions that, at times, did not involve one-to-one peer interactions. As the PS-ESTs reflected on their experiences or observations, they incorporated components of different identity dyads (e.g. individual and content, content and context); analysis of these dyads was made using the idea that interactions generated dissonance.

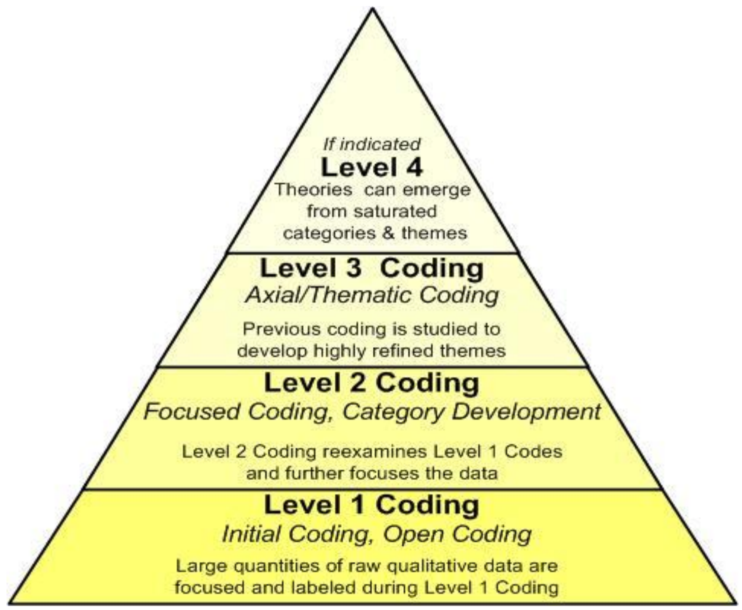
Figure 3.1: Perceptual Control Theory



Constructivist Grounded Theory

Constructivist grounded theory was utilized to analyze the data. This theory is defined by a set of systematic inductive guidelines for collecting and analyzing data in order to build theoretical frameworks or assertions that explain the data based on the context from which the phenomena it contains originates (Corbin & Strauss, 2008; Creswell, 2008). Grounded theory was developed as a systematic inquiry process that could yield data analysis and reduction with empirical validity (Cervetti, Barber, Dorph, Pearson, & Goldschmidt, 2012; Denzin & Lincoln, 2005); using it is beneficial because it generates opportunities for the development of assertions (*See Figure 3.2*) (Creswell, 2008).

Figure 3.2: Grounded Theory Coding



Because grounded theory is designed for the development of theories or assertions, how data are approached requires the development and refinement of conceptual questions on a generic level. The right questions allow for discoveries and the clarification of conceptual ideas through the dissertation writing process. Frameworks to make assertions or generate theories can be developed through a constant comparative analysis that makes use of coding schemes and memo-writing (Corbin & Strauss, 2008). Even though grounded theory is intended for the aforementioned purposes, the researcher must be aware of tendencies to be formulaic. The key for success is an open-ended data analysis and reduction (Berland & Hammer, 2010) that assumes the researcher or the research subject to be the creator of knowledge. Through grounded theory, the data are not intended to illuminate objective reality. The idea is to use theory to permit the researcher and the participants to confer meaning on what is observed (Creswell, 2008). Interpretive understandings can be used to develop the results and implications (Creswell, 2008). Though constructivist grounded theory is systematic, data collection is not focused on rules, procedures, or theory verification, but the perspective of the observer/researcher. What is viewed is filtered and interpreted in a way that does have bias, but also gives meaning to the findings. A grounded theory approach was used in the interpretation of the PS-ESTs' blog posts and comments. Themes emerged with respect to how students constructed their understandings of science teaching. Despite the fact that grounded theory produces methodological guidelines for generating themes, it is intended to have a limited theoretical position (Kushner & Morrow, 2003). To counteract this, the use of broad theoretical perspectives is chosen to produce sensitizing concepts (Bowen, 2006), which situates the context of interest within a larger social structure (Corbin & Strauss, 2008). These sensitizing concepts are not anecdotal—they were framed by perceptual control theory and derived from a thorough review of the literature associated with the strands discussed in chapter two.

Analysis

PCT and grounded theory informed the coding of data. Prior to initial coding, the decision was made to base pre- and initial codes on ideas produced by the review of literature. This emphasis involved using perceptual control theory (PCT) (Burke & Stets, 2009) to define ideas associated with PS-ESTs' perceptions of their settings, themselves, and others. These perceptions also included interactions with cohort members, and eventual expansion of the idea of interactions to include other influences such as cooperating teachers (CT), other contextual agents, or content. Data were coded by analyzing sentences or paragraphs in each blog post for each respective individual. These data were then grouped based on individual authorship, cohort membership (ten per cohort) and enrollment as a PS-EST (twenty overall). The first stage of analysis looked at the largest grouping (PS-EST enrollment). Analysis then focused on looking at each cohort as a separate unit. Subsequent analysis of each cohort and the individuals focused upon differences between the two cohorts with a final stage of analysis. This step was attentive to observed differences that set apart some individuals in contrast to the at-large group or each cohort. Analysis also involved any findings considered unique to blogging.

The selected data from the pre-service elementary education majors were analyzed inductively and deductively. Once data analysis was completed, inductive reasoning was used to make generalizations about the PS-ESTs, the structures that they occupied or the interactions that occurred. By analyzing the data using a grounded theory structure (Corbin & Strauss, 2008; Kushner, 2003) and coding the data through the use of sensitizing concepts (Bowen, 2006) (Burke & Stets, 2009) distinct themes emerged in relation to the questions being asked.

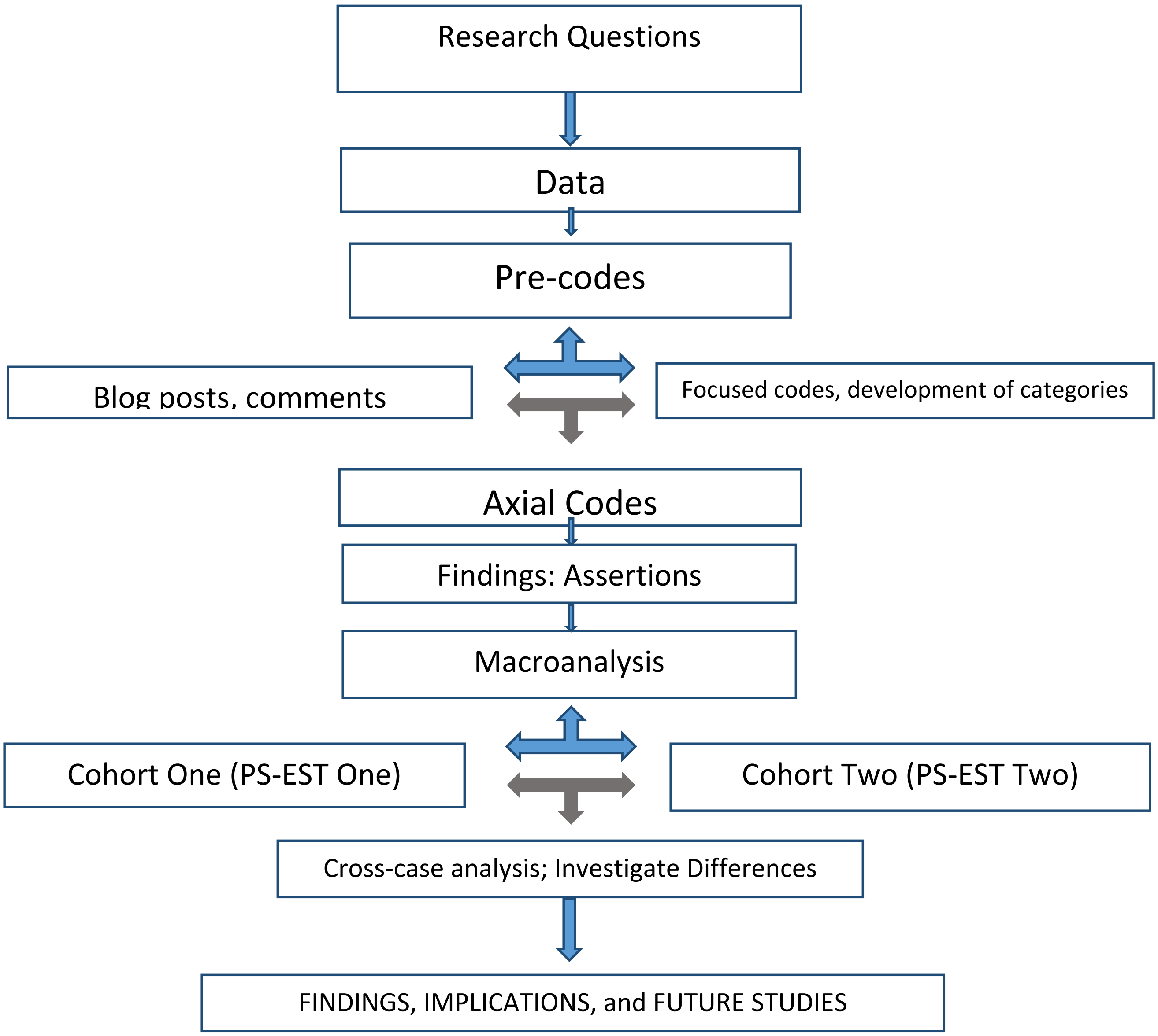
After the pre-coding phase, the twenty selected blogs, ten from the first cohort and ten from the second cohort, were subjected to level one coding. This level one coding focused on developing inferences based on all the data by reading each comment sentence by sentence. A code was then assigned based upon the sentence's content and the context that the post or subsequent comment represented. In alignment with grounded theory (*Figure 3.2*), codes that emerged during pre-coding and those that emerged from level one, open coding were collapsed into an axial coding scheme. These codes were subjected to an iterative and inductive process (Corbin & Strauss, 2008) with any outliers revisited towards the completion of level one coding. These outlier statements were re-evaluated based on an unusually low frequency (less than five times). The data, in general, were also examined for outliers defined as minimal iterations of a specific code (e.g. less than five occurrences). These outliers were re-examined to determine if the data should or could be recoded. If not, the outliers remained as is. In most cases, the outlier was recoded—a practice attributed to increased familiarization with ideas associated with the codes being utilized. After re-evaluation of all outliers in relation to codes, level one groups were developed (*See Appendix 4A*). The new list of codes was generated based on the initial sensitizing concepts with changes made because the original concepts were refined through analysis that illuminated nuanced differences.

During coding, copious notes were made. These notes were utilized along with the codes and perceptual control theory to generate categories, level three in figure 3.2. These categories were generated by looking across the data as a set and data for each separate cohort. The categories were as follows: personal agency, structure, and interactions. Personal agency related to the first PCT postulate about identity, the internal dynamics of individuals that operate within specific roles, and structure corresponded to the second PCT postulate, the integration of contextual inputs as the individual enacts a perceived role within a context. While theoretical literature acknowledges agency as activity or action, the decision was made that perceptions were a form of belief and that belief constituted a component of agency. These beliefs were frequently coded as perceptions or expectations that the PS-ESTs acknowledged in their initial blog posts. Personal agency captured explicitly stated actions by the PSTs, perceptions about teacher's roles, and prescriptive values for student learning. Structures represented any objective influence that the PS-ESTs were exposed. These structures included: a) professors or instructors, b) cooperating teachers, c) peers, and d) historical figures such as previous teachers or role models. The PS-ESTs posts contained these structures and subjective references. Even though the subjective references were cited in the posts, the posts were analyzed to understand the objective influences mentioned by the PS-ESTs. Developmental dyads were influences generated by the interaction between two distinct entities. These could be one-on-one peer interactions, PS-EST-structure interactions (e.g. PS-EST and CT), or structure-structure interactions (e.g. students and content). These dyads were important because they represented perceptual inputs that generated dissonance or disruptions associated with PS-ESTs understandings of science teaching roles.

Summary

This chapter outlined the key characteristics of the research study including its purpose and design. Also, this chapter highlighted the frameworks and perspective used for designing and implementing the study and for analyzing the data collected. The iterative approach to coding the blog posts and comments was described, and the appropriate definitions were presented. Chapter four looks specifically at the findings generated from the analysis of PS-ESTs' blogs.

Figure 3.3: Research Design



CHAPTER FOUR

FINDINGS

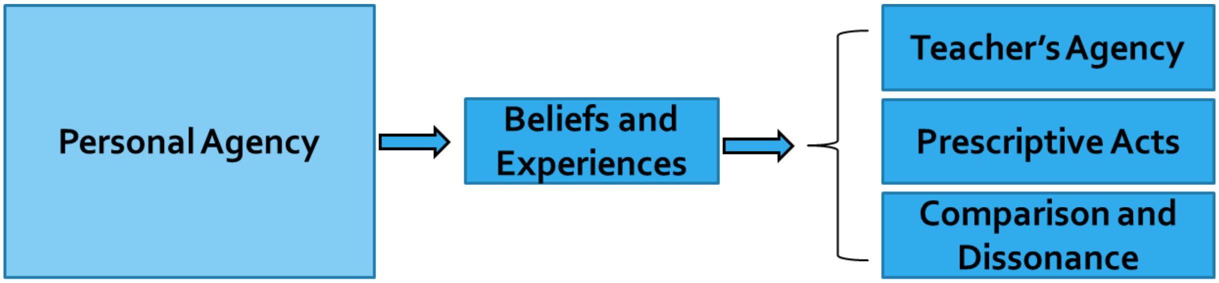
This chapter presents the findings from an analysis of cases from two different cohort's multimedia blogs. The case unit, individual blogs, for each participant was approached with the intent of learning about PS-EST identities, influences on these identities, and potential assertions for teacher education practices for elementary science teachers. These findings were bound by consideration of four unique perspectives: the role of the individual, the role of the context, and the interactions that occurred within the contexts or among individuals. Using these perspectives, the data were analyzed to develop assertions about the science teaching identities of PS-ESTs.

Perceptual Control Theory [PCT] organized the findings. This theory acknowledges the influence of context and individual identities on a person's practices and perceptions (e.g. Burke & Stets, 2009; Gee, 2000, Lawler, 2009). Elements from PCT—personal agency, structure, and interactions—were used to organize the findings and within this frame, the themes and subthemes that emerged from the data were discussed. These findings were then categorized into one of three main groups, each with distinct themes associated with it (Figure 4.1).

Personal agency was the PCT element used to frame the analysis associated with beliefs. The following sub-themes emerged from the data: 1) teacher's agency; 2) prescriptive acts for student benefit; and 3) comparisons and dissonance (*see Figure 4.1*). Structure was the PCT element used to frame the analysis that included the following themes of situative meaning and social influences (*see Figure 4.2)*. Situative meanings included the sub-themes of school culture and the role of science. Social influences included the sub-themes of student inputs and non-student inputs. The third PCT element used to frame the analyses was interaction. The theme developmental dyads emerged within this frame. Developmental dyads included the following subthemes: 1) peers and 2) non-peers, which focused on student interactions with content (*see Figure 4.3)*.

An assumption was made that the PS-ESTs entered their methods courses with ideals about how to teach science and these ideals would be conveyed in the blogs they constructed. Given the nature of PCT, the structures and interactions that occurred in the PS-EST experiences produced disruptions and contextual tensions, respectively. Disruptions were moments that produced a reflection by the PS-EST that illuminated how they approached teaching and the incongruity in how it transpired when they were actively engaged in authentic learning environments. These disruptions sometimes resulted in an alteration of practice in the immediate environment or a reflection based on what would occur in future iterations. Contextual tensions were tensions that included the PS-ESTs processing information associated with interactions in the learning environment. These interactions generally revolved around science learning and were important because they signified something of value to the PS-EST associated with learning activity.

Figure 4.1 Personal Agency



Personal Agency

Personal Agency was based upon ideas evidenced in theoretical and empirical studies that dealt specifically with subjective components of the PS-ESTs identity such as a belief or acknowledged historical or contemporary action that elicited a belief. These beliefs were associated with the PCT feedback loop, specifically the identity standard (Figure 3.1), and often represented a deliberate action or thought associated with personal agency. For example, a PS-EST might respond to a cooperating teacher by performing a specific act or by referencing what they would do in a similar situation. Within the frame of personal agency, several themes emerged from the data: teacher's agency, prescriptive acts for student benefit, and comparison or dissonance. These themes were fully elaborated in the patterns evident in the data. These patterns related to the following: 1) perceptions of self as teacher; 2) critical beliefs about teacher roles; 3) adaptations of practice; and 4) anticipation of future practices.

Teacher's Agency

This theme involved the PS-ESTs' considerations of the teacher's role and represented a form of belief or perceived understanding about teaching. Given the relative lack of authentic teaching experiences that each PS-EST had, these beliefs were considered, at times, to be naïve yet accurate personal conceptions of the teacher's role in association with science teaching in the elementary classroom.

Perceptions of self as teacher. PS-ESTs recognized their roles as academics yet also acknowledged their academic practices extended beyond the academic classroom to their future preparation as teachers. While navigating the various experiences and knowledge generated through academic classes or field experiences, PS-ESTs revealed how they perceived themselves and their roles as teachers. Their perceptions of themselves as teacher included several aspects.

***Awareness of gender tendencies*.** PS-ESTs were predominantly female with only two males present between the two cohorts. Members of each cohort did not address the gendered asymmetry of the cohort in their posts, but acknowledged awareness of gendered norms in the elementary classroom in which they had authentic learning experiences. The insightful posts indicated that the PS-ESTs were aware and thinking strategically about how to handle challenges associated with historically normed behavior, as shown in the example below:

> Although the girls talked a little bit more this time than last time, it was evident that they were holding back because they felt like the boy in their group knew more about it than they did and even when directly questioned, they would begin to respond, but more or less, pass off the question to the boy in their group. This causes me to wonder what would happen if we grouped based on gender, boys and girls. Would the girls perk up and work together or would they work at a slower pace and watch the boys on the other side of the table to replicate what the boys do? Of course, I also feel like if we split the students up based on ability, then our groups would look like tracking. It's that question that has never really been answered for me, where is the dividing line

> between differentiation and tracking? We hear about how great differentiation is and how we should stay away from tracking in elementary grades, but where is the line drawn? (Sarah, blog post)

Sarah's statements acknowledged common concerns associated with gendered norms. Typically, boys initiate conversations while girls are tentative (e.g. Anderson, et.al. 2013; Bautista, 2011). Though they clearly have a grasp of ideas associated with content activities, girls are more likely to defer to the boys in the group (e.g. Brotman & Moore, 2008; Archer, DeWitt & Willis, 2014). Sarah's observation indicated that the PS-ESTs were aware of normed behavior (Bianchini, Cavazos, & Rivos, 2003; Moore, 2007). Even though the PS-EST indicated an awareness about gender, this awareness was lacking with respect to content.

Content limitations. Though PS-ESTs viewed science-based learning as valuable to student growth and development, their reflections and comments indicated uncertainty about their own content competency.

> Overall, I felt ok about this lesson. I think that Anna and I had a pretty solid structure to our lesson, but I was not very comfortable with the content that we were teaching. (Zoe, blog post)

> To be completely honest, science is the subject that I feel least confident in teaching. I really enjoy science, especially at an elementary school level (there are so many fun things you can do with the kids!), but I feel as though some piece is missing for me – I'm not sure if my confidence level is based on the fact that I don't know the content thoroughly enough, but I do think that it isn't as easy for me as literacy or math because it wasn't instilled as

something normal for me when I was in elementary school. (Addison, blog post)

Teacher content knowledge was mentioned because of specific lessons, not because the PS-ESTs were contemplating its use or their need for understanding in order to teach. The PS-ESTs did not address or acknowledge strategies to improve their own content knowledge competencies, instead they concentrated on the use of materials (e.g. quantity, sequence of use, or the division of responsibility among students). When speaking of content, they acknowledged personal limitations, but the PS-ESTs spoke without explicit admission of their need to tackle content competency issues.

> For elementary, I always remember being really excited about doing any of the hands-on activities, but always getting a rush of anxiety as soon as the worksheets were passed out because I knew that I would get the questions wrong. Lyndsey, blog post (Stella, blog post)

> I think that Anna and I had a pretty solid structure to our lesson, but I was not very comfortable with the content that we were teaching. I had a harder time connecting the concept of building a parachute with the objectives of forces and motion of 5th grade. –Alexis, blog post (Zoe, blog post)

The PS-ESTs' reflections and comments about their practices indicated that they minimized perceived shortcomings by paying attention to other components of their pedagogy. For example, in the following post Sarah acknowledges competency based on experience, knowledge of students, materials, and method without giving specific attention to content itself. Sarah's post, like others, revealed an unexpressed awareness that successful lessons were such because they accomplished specific outcomes.

> I felt very prepared to teach this lesson with Elizabeth because we had taught the lesson previously with a different age group and I knew that we would have had a chance to work with the same students earlier in the day during our critical literacy and math lessons. Furthermore, we ourselves had used the materials for this experiment a number of times throughout the semester, so I felt very comfortable using and distributing the materials to students, knowing exactly how much to cut. (Sarah, blog post)

Multiple posts mentioned developing competency with the mechanics of lessons generated through contemporary experiences while rarely addressing concerns with content.

Content Strategies. As stated, PS-ESTs did acknowledge limitations with content as they spoke about challenges associated with the mechanics of lessons. However, these mentions of content knowledge were usually responses to challenges associated with contemporary experiences.

> In our first lesson, when we felt that student questions were steering our lesson in a different direction, we were a little uncomfortable on how to address this because we couldn't answer some of the questions. (Zoe, blog post)The students were very attentive, and loved constructing their parachutes. Also, Sarah and I were much more comfortable and prepared to teach the lesson since we had already taught it with 2nd graders. One thing we could have improved on was giving more clear instructions. The students wanted to take almost a half-hour to construct their first parachute attempt. Next time, Sarah and I will give the students a time line, so they aren’t taking more time than needed. (Madison, blog post)

Zoe mentioned discomfort due to how "student questions were steering our lesson in a different direction." Zoe's post indicated two sources of PS-EST anxiety: content knowledge and preferences for routine. These posts of PS-ESTS also indicated anxiety. One strategy the PS-EST employed to alleviate this anxiety and compensate for limited content knowledge was to emphasize the logistics of the lesson (e.g., provide clear instructions) and to truncate lessons to ensure certain outcomes.

The challenge was that the PS-ESTs focused their reflection on procedural knowledge without indicating how their efforts could be redirected to develop further conceptual understanding of content—their own or their students. The need to improve content knowledge was not denied by the PS-ESTs. The problem was that minimal content knowledge was accepted and rationalized. For instance, PS-ESTs referred to their perspectives about content knowledge sources:

> No one wants to read a textbook. I rarely read them in high school and definitely didn't in most of my classes in college (I've gotten better about actually reading for classes). I always struggled to follow the text and understood the material so much better from lecture, so why bother reading the book? (Camilla, blog post)

While referencing an issue associated with textbooks, Camilla raised concerns about knowledge sources. These concerns were based on realities that content knowledge could be learned experientially. This learning also required the use of published materials, such as a hard copy of a text or a validated website (www.NAP.edu). The PS-ESTs' discomfort with this mode of knowledge acquisition was a challenge because the PS-ESTs' uncertainty about content competency were occurring at a time when their experiential learning required minimal use of knowledge-based texts. While twenty-first century media enhance knowledge acquisition through the use of virtual references, Camilla's post did not acknowledge these potential sources. This lack of acknowledgement occurred despite PS-ESTs using digital media as a tool to interact with each other. Zoe's post revealed that she, like other PS-ESTs, learned from the feedback generated by their field experiences. This, in turn, was utilized for future preparations. However, no direct strategy for addressing content challenges for future practices emerged.

Facilitator. Because the notion of facilitator was observed and recorded in the PS-ESTs' blogs, some analysis involved determining what the idea embodied. Initially, facilitator was thought to represent the teacher's role with students during student-centered practices (e.g. student-led vs. direct instruction) that were purposeful efforts to encourage specific learning outcomes. One finding included the idea of inquiry. As an approach to learning, inquiry was important to the PS-ESTs and the nature of learning associated with it. While beneficial, inquiry required a carefully scaffolded classroom environment. In these environments, teachers enable student exploration through questioning and hands-on learning. By allowing these types of student explorations, the PS-ESTs assumed that students would be challenged in their conceptual understanding, shifting their knowledge. Besides content objectives, reliance upon this type of facilitated discovery extended to acts of empowering students, giving them ownership of their learning. For example:

> Learning through inquiry is more engaging and helps the students to make sense of the content taught. The students are able to participate and do the learning themselves rather than just read what someone else thinks out of [a] textbook. (Ava, blog post)

> I think there are benefits to inquiry based learning that definitely support the student's learning. The students figure out a lot of the needed information out on their own through experiments. (Brooklyn, blog post)

Based on their posts, the PS-ESTs emphasized student comprehension and proper understanding through the use of varied approaches, though little mention was given to specific strategies or how they would be implemented. When addressed, details of purposeful activities referenced classroom rules and procedures directed toward governing student interactions or maintaining order versus generating an environment that encouraged student-centered content learning. The PS-ESTs revealed a distinct lack of emphasis on how to specifically influence student comprehension, assuming that the activity would inherently produce desired outcomes. This was seen in the following excerpt from Savannah's blog:

> I know that it will be important to establish clear rules and expectations that put respect at the forefront of discussions. Though I want my students to feel like they are able to share their opinions and ideas even if that means they disagree with someone else, I want them to realize there is a respectful way to disagree.

Though good intentions were present, strategic planning intended to address scaffolding to facilitate student learning was absent from the PS-ESTs' reflections and conversations. The PS-ESTs clearly acknowledged their recognition that student understanding presented challenges; however, besides acknowledgement, no strategic plans for navigating students through learning were mentioned. What was evident from the blog posts was that facilitation required a certain type of environment. .

Establishment of a type of classroom environment. PS-ESTs referred to the classroom environment and acknowledged that the teaching of science consisted of multiple components. When viewed holistically, science teaching and learning included classrooms that used published curriculum and focused on the development of skills beneficial to inquiry learning. The PS-ESTs' noted ambitions were that their classroom practices would encourage science learning, the use of scientific practices, and the use of science for the development of non-content related abilities, such as critical thinking and engaging in civil behavior:

> Students must be able to apply and explain scientific concepts, generate scientific evidence, reflect on scientific knowledge, and participate in a science community to be able to be proficient at science. Students cannot progress in science if they are in environments that do not support the advancement of the four strands. With textbooks they are not being emerged [sic] in the concepts. (Liliana, blog post)

> As teachers we can all help our students develop skills in discourse and argumentation. But in order to do this we must first set up our classroom to be an environment that is based on trust and respect for everyone. Once students feel respected and trust that they are in a safe place, they will be more willing to share their own opinions and engage in discourse and argumentation. (Victoria, blog post)

The PS-ESTs wanted students to value school and saw engagement as an indicator of this. Engagement included a PS-EST perspective that science teaching efforts were dualistic:

They should be designed with an academic rigor in mind, yet also needed to utilize types of learning that gave students some degree of respite from the demands of daily learning typically allied with other content areas. Approaching learning in this way meant that science was more than academic; it was a form of engagement that allowed the students to have fun and put other core content areas aside. This perspective revealed that the PS-ESTs valued science, but did so in a way that differentiated it from other content areas rather than integrating it with other content areas. Their comments implied, and at times explicitly stated, a focus on other content areas:

> I don't know if this is bad to say or not, but I feel like science can be a fun part of the day where students get a break from the super rigorous work and can think for themselves and have some fun with the hands-on activities. I think science can also be fun for teachers to teach because everything is not so based on the test and is more based on good practice by the teacher. The students do find science intriguing which also makes it easier and more fun to teach because the students are interested. (Skyler, comment on Gianna's blog post)

As previously noted, the PS-ESTs regarded engagement as a valid science learning goal. This engagement emphasized fun. "Students need to be able to see the importance and fun of science in the world around them" (Penelope, blog post), or "Legos would be a really fun and interactive way for students in the fifth grade to explore forces and motion" (Liliana, blog post). In the elementary classroom, science was governed by affective values associated with making the class or the content enjoyable to the students. .

PS-ESTs also value the well-being of their students, placing an emphasis on how the classroom impacted the student—was it a safe haven for student learning? The PS-ESTs desired that the learning environments be a place where students did not feel put down or discouraged because of still developing conceptions as shown in the examples that follow.

> Often students have the fear and anxiety that comes along with not knowing something or finding out that they are incorrect, which is why it is up to us as teachers to make the classroom a place where students feel safe and welcome to express their thoughts. (Eliana, blog post)

> It is important in classrooms because students must learn how to have productive conversations about a topic. I think that a key component to conversation is each party [sic] developing an ability to respect all parties involved. The classroom can be a safe environment for students to begin developing this skill of respectful, production conversation. (Ava, blog post)

> However, there were a few classrooms in which the teacher created an environment that made me feel comfortable enough to come out of my shell and share my ideas with my peers. In these classes I would raise my hand multiple times a day, and even if I was wrong, it wasn't a big deal. In order to achieve a classroom like this it is necessary to make sure that the students are comfortable with one another—Make sure they get to know each other. (Mila, blog post)

Making the classroom a safe place for students was associated with affective preferences for student engagement and excitement. In producing such an emphasis, content practices are directed, if not dictated, by the students in the classroom, or other beliefs about teaching roles (e.g. emphasis on the importance of literacy). These values elevated students by ensuring that they did not feel a need to fit into a specific mold or constantly agree with the teacher or each other. However, differences did not excuse the need for students to respect each other, recognize differences in individual perspectives, and trust the intentions of the teacher.

Critical beliefs about teacher roles. PS-ESTs spoke of themselves as teachers and their reflections gave specific indicators of what this entailed. Posts produced revelations about PS-ESTs' beliefs associated with teacher roles. These beliefs involved various ideas about pedagogy centered on knowing students and being facilitators of classroom activity.

Developer. As developers, PS-ESTs saw the teacher's role as important in two distinct ways. One involved preparing the students for their academic careers; the second saw teaching as a means to develop the students' life skills. For academic preparations, the PS-ESTs perceived that the teacher's role was to encourage student learning by focusing on ways to improve student understandings, including correcting inaccurate conceptions of knowledge. Along with confronting these misconceptions, the teacher's role also included motivating and engaging students through activities designed for specific content goals. These activities were intended to produce an immediate impact on student knowledge while also fulfilling long-term academic purposes of preparing students academically. For example:

> If science is neglected in the younger grades students will be missing essential opportunities to develop an interest in the material and to develop critical thinking skills that are brought to the forefront in science experiments. Also, if it is not addressed in these early years students who are interested in scientific topics will not be given the opportunity to explore their interests. (Savannah, blog post)

> Our world is sending out a call…we need all scientist hands on deck! I would especially hope that this board member has children so that I could argue that if his kids start to learn science early, such as how a computer works, or how to fuel beneficial plant growth, they'll be their own problem solvers. (Stella, blog post)

Beyond an academic focus, the PS-ESTs saw the teacher's role as one that encompassed efforts to generate skills or mindsets beneficial to life. The teachers utilized classroom practices that were intended to teach and enhance student decision-making ability, the development of interpersonal skills, and the ability to think critically and solve problems. These life skills were exhibited through posts such as the following:

> When I was in theater in high school, they taught me how to take constructive criticism, which overall helped me be a better person. If children can learn to do this at a young age, then they will be able to control their decisions on life better. (Bella, comment on Camilla's blog post)

This developer role, whether envisioned for the immediate classroom, the future one, or elsewhere, was important because it connected the PS-ESTs' perception of content roles and science-based activity in the classroom. Given the PS-ESTs' hesitation and anxiety when faced with the task of teaching science, such perceptions were viewed as important to their identities as teachers, giving content value beyond its inherent worth.

Knowledge of students. Posts associated with knowing students produced two themes that exemplified how the PS-ESTs approached students. The first theme involved PS-EST observations and perceptions of what was immediately occurring with a specific activity. The second theme involved a general perception of students and included references to prior knowledge and what generated student conceptions. Posts containing elements associated with these themes could also be generalizations about students' scientific knowledge, based on what was observed in the classroom. For example:

> Students come to us not as blank slates that we can just inscribe content onto, but as a collage of thoughts, ideas, theories that they get from all sorts of credible and disreputable sources. They pick up information from families, peers, and the media. They could just come up with a theory from a misunderstanding. (Madison, blog post)

The PS-ESTs' posts and comments centered on practices that emphasized students and their responses during science-related activity. These posts indicated that knowing students' prior knowledge was secondary to knowing what they were doing or thinking in contemporary classroom activities. Knowing students current understanding was valued by the PS-ESTs. For example:

> The second graders had some difficulty getting started on making their parachutes, but these boys knew exactly what to do. We were also able to have a more in depth discussion about the concepts involved with making these parachutes such as air resistance and air pressure. Before they made their parachutes, we had them draw a picture of what a really efficient parachute would look like. This helped them make predictions about what their parachutes would need to have in order to fall the slowest. (Liliana, blog post)

Generally, PS-ESTs viewed their students with academic content in mind. Posts reflected an emphasis on encouraging or enhancing students' scientific understandings. While an important and critical belief for science teaching, the PS-ESTs did not address how this knowledge could be used to design or shape instruction. How they processed student input and utilized it strategically are also addressed.

Processor of student input. The PS-ESTs' primary emphasis, when considering student outcomes and knowledge, was two-pronged. One prong prioritized spontaneous student input and reflection generated by involvement in contemporary experiences. The second prong of the PS-ESTs emphasis was a focus on determining students' current knowledge base. The PS-ESTs' reflections revealed their belief that a good teacher would evaluate and assess students prior to activity, during activity, or upon completion of it. Whether spontaneous or specifically designed to develop formative understanding of students, inputs were used to learn more about student understandings—while the chronological position of the assessment determined if it was a formative or summative practice. Formative assessments were defined by posts such as the following:

> The first step to creating this effective lesson is to first assess students to discover what they already understand and what are their confusions. This is helpful because you won't have to teach what they already know [sic], which would be boring and unhelpful to the students, and you can target a misunderstood portion of the content. (Madison, blog post)

In another blog post, Hannah noted, "So, we need to be assessing our students during each lesson and use that information to their benefit." Knowledge gained from synchronous assessments served multiple purposes. These included determining the students' prior conceptions, gauging student comprehension, and determining the appropriateness of the methodology applied for the particular activity or learning being utilized. Examples were common in the blogs such as the following excerpts from Liliana and Stella, respectively, show:

> It is nice to have assessments from previous teachers, but you also need to present the students with your own assessments as even they are coming to you with a clean slate. You need to build your own understanding of what a student knows based off your observations as their current teacher, and the relationships you build as you get to know your students will help you to know how to plan your lessons based on their needs.

> In my future classroom, I would want to identify the strong ways in which each student comprehends, expresses themselves, and stays engaged in learning. This information can be collected through informal observations,

home visits, genuine interviews and conversations, and interest/learning style surveys.

For summative assessments, the PS-ESTs looked at students' level of engagement or excitement and also gave some consideration to content knowledge comprehension. Engagement, or lack thereof, was always a major key used to gauge the utility of the lesson.

As previously discussed, two categories of benefit, academic and life, were used to determine the benefit of science in the classroom. The utility of assessment also involved some form of benefit to the student. Academically, these benefits could be either immediate or future-oriented. In an excerpt from a blog post by Layla, an immediate academic benefit was considered:

> The most important strength of the kit is that i[t] addressed Student's misconceptions…I would explain the importance of knowing student's misconceptions in the beginning and reevaluating them at the end. If the students tell you something that raises a red flag, then you know something you need to additionally teach the students.

In Addison's blog post, a reference to future academics was made:

> If you try to push science out of elementary curriculum, you're closing so many doors for so many kids who are able to shine when it comes time to do science. Teaching students how to access and analyze information as they are able to do in science is a key skill we should be highlighting for our students.

Though assessment was seen as an important gauge of student comprehension or engagement, the PS-ESTs generally spoke of formative assessments that occurred simultaneous with the lesson but did not discuss standardized assessments. Standardized assessment as a means of input from students was virtually absent from the blog posts. When mentioned, standardized assessment was as an overt influence on science, dictating what should be learned in the classroom content wise but not how science was taught. This excerpt from Alexandra's blog illuminates PS-EST perceptions of standardized assessment on science in the classroom:

> When I look back to my elementary school years, I have realized how much has actually changed. We still had standardized testing, but there was definitely not as much stress on it. I feel like the writing test was more important and that was what was emphasized the most (which is easily incorporated into any topic). Science was never super important in my class, but they introduced it to us to prepare us for middle school.

The lack of mention of standardized assessments associated with science, especially given the increased emphasis on STEM as part of the national dialogue on science, was telling in two ways. The PS-ESTs' acknowledgement of science in their own practices was a result of exposure to science dictated by historical practices not in their current experiences as PS-ESTs. The second influence associated with standardized assessment was that the PS-ESTs exhibited tendencies to adapt to the salient demands of their context. In the current context of their field experiences, standardized assessments with school-wide impacts occur in literacy and math; the uses of these assessments prioritize reading and math over other content areas in terms of instructional time. While the tendency to adapt to the demands of the context is good in the undergraduate classroom that is scaffolded to encourage science teaching and learning, the lack of strong contextual emphasis typical to elementary schools meant that science teaching would diminish until more contemporary assessment practices became ingrained in the elementary school subculture.

Facilitator. PS-ESTs believe that a teacher is a facilitator and role model that generates influence and creates a learning environment supportive of student development. The teacher-facilitator is also a guardian who provides appropriate rules, guides student understanding, and aids conceptual change through the use of varied methodologies, an appropriate amount of intervention, and the development of a professional profile defined by efforts to minimize imposing authority on the students. As noted by posts such as the following, PS-EST's reflections and comments indicated that PS-ESTs wanted to produce natural conversations and inquiry.

> One of these roles is facilitator. This student has the responsibility of keeping the group on task and making sure everyone is participating. I think giving each student a role to be responsible for is brilliant because all students are sure to engage in the activity because each person has a responsibility that they must carry out or the task will not work and be completed. Facilitator, specifically, is important to group conversation because that person makes sure that discussion is relevant, focused, and moving. If some individuals are not contributing, they check to see if they have something to add to the conversation. Naturally, I would move about the classroom during these discussions, but I would make sure to give the students enough room so that they would have the opportunity to have natural, quality discussions. (Stella, blog post)

PS-ESTs believe that the purpose of the facilitator/guide role is to improve student learning. This was accomplished by paying attention to student needs and efforts to make what was done in the classroom relevant to the student's immediate or future academic success and life outside the classroom in the "real" world. Excerpts from Emily's and Evelyn's blogs illuminate these aspects of the facilitator's role.

> My goal as a science teacher will be for students to be able to connect what they learned in the classroom to something they experience at home or outside of school that very day! For example, we are getting ready to learn about Earth, Moon and Sun. One objective I know off the top of my head is that students will be able to explain where shadows come from. After learning about this in class, students can step outside, look at their own shadow, and understand what is causing it. This is just one example of how I would like to always be having in mind how I can connect what I am teaching in school to students' lives outside the classroom. (Emily)

> Depriving students of exploring their questions while in school is a disservice to them. Not all children have ways that they can explore their own curiosities so it is up to us as teachers to help them explore the world around them. (Evelyn)

The PS-ESTs recognized that classroom activities were important for their students' development and that a deliberate effort was both necessary and varied. Facilitation primarily involved a philosophical approach to how students should learn (e.g. exploration, inquiry). Regardless of the focus of a particular lesson or activity, the PS-ESTs saw the facilitator's role as important because student learning deserved a commitment to specific practices and because students gained long-term benefits from facilitated learning.

The second theme that emerged under the PCT element of personal agency pertained to the PS-ESTs' imaging of students. Students were preeminent in the PS-ESTs' blog posts.

Prescriptive acts for students' benefit

Students occupied a prominent role in the PS-ESTs' blog post reflections and comments. The PS-ESTs' views of students influenced the personal agency of the PS-ESTs. Students were always considered during lesson planning and the PS-ESTs' reflections on them and their activity produced various insights about the role students played in shaping the PS-ESTs' expectations for the teacher's role.

Perceptions of Students. PS-ESTs referenced their charges as "students," "children," or "kids" which indicated their personal awareness of the student. The PS-ESTs perceived the students in very different ways; these perceptions seemed intertwined with their practices.

One of the PS-ESTs' consistent goals was to value their students as members of a group that could contribute to learning, making it a sociocultural activity that highlighted participation. The PS-ESTs encouraged student participation by working as facilitators who embraced students learning from each other. This was accomplished by strategic uses of scaffolding in lessons aided by the PS-ESTs' supervision. The PS-ESTs were aids to student discovery, and though nothing was explicitly stated, blog posts indicated that PS-ESTs approached ideas of science pedagogy by valuing the teacher's ability to guide students through the construction and self-discovery of knowledge. This practice included structuring the classroom so that discovery was possible, as shown in these examples:

> Along with physical objects in my classroom, I will also ensure that I have strategy groups set up so that the students within them are learning from each other and working together. These groups will be set up based on needs and abilities. Overall, all of these elements of UDL will help all different types of learners have an equal learning experience in the classroom. They can easily be incorporated across the curriculum because each element is not specific to a certain subject. (Eva, blog post)

> When I teach my unit, I will be incorporating both of these aspects. Not only will my students be doing experiments but they will also be doing a research project in a group where note taking skills are required. By having students in a group, they can also learn from each other and use each other's skills. (Alexandra, blog post)

PS-EST perceptions were sensitive to student engagement and used such inputs to determine how to structure activities and practices. Though not clearly defined by explicit statements, student engagement was associated with students working on a planned activity while exhibiting excitement and interest; these latter variables appeared to be a key determinant of a lesson's success. This presumption was reinforced by the use of the terms "excitement" or "engagement," or some derivation of them.

> Overall, I think that using LEGO robotics in the classroom is a great way to keep the students *engaged* (emphasis added). I feel that with better *engagement* (emphasis added), the students will write better reflections on their experiments. It will be easier to assess student learning if they wrote

extensive reflections and observations about things they were *interested in* (*emphasis added*). (Eva, blog post)

PS-EST reflections that were related to their perceptions of students and practices were limited to the context of academic coursework; these reflections did not indicate that these perceptions and practices were associated with the PS-ESTs' field placement within the local classroom. These reflections revealed a PS-EST belief that student-centric practices were beneficial for student conceptions of science.

Students' misconceptions. "It is critical that teachers assess student knowledge in order to better inform instruction and increase teacher accountability" (Sarah, blog post). This statement revealed one of the focal points of the PS-ESTs' academic coursework, misconceptions. The term "misconception" refers to a view or opinion that is incorrect because it is based on incorrect understanding of scientific phenomena (Burgoon, Heddle, Duran, 2010). The PS-ESTs understood that students would have prior conceptions of content, which were viewed as beneficial to future learning of science, and thought it important to address understandings identified as misconceptions. For example, Savannah notes in the following excerpt:

> Science is everywhere in their lives and if we neglect to address these concepts at a young age they will have many unanswered questions and misconceptions about how things are will overwhelm their thinking. Things like the weather, seasons, animals, and sports activities all involve science topics that students would benefit from being exposed to. Fostering these understanding early will provide a progressive understanding for students as they explore various topics over time. If these understanding are not addressed

> early on there is essential time lost to build understanding that is appropriate at different development levels. (Savannah, blog post)

Though misconceptions were acknowledged repeatedly in reference to specific student learning experiences or general trends associated with certain content areas (e.g. air resistance, surface tension), the PS-ESTs' posts indicated that PS-ESTs underestimated the difficulty associated with addressing student conceptualizations of these science ideas. The PS-ESTs did not acknowledge particular strategies other than awareness of misconceptions, nor did they consider conceptions in light of students' funds of knowledge (González, Andrade, Civil, & Moll, 2001). Indicators from the posts showed that PS-ESTs' recognition of misconceptions, either through assessment of students' content knowledge or general recognition illuminated in published curriculum or through expert voices, satisfied their concerns. Savannah, Stella, and Gabriella all demonstrated this type of recognition of conceptual understanding as shown in these excerpts from their blogs:

> What students go into a class knowing will influence and shape how they understand the material and how they tackle the assignments. These experiences shape their conceptions and misconceptions about the topics they learn in school and ultimately the world.…[I]t is essential to use students' understanding and prior conceptions to plan, instruct, and assess because their funds of knowledge set the stage for their educational experiences. If we do not understand what our students come into the classroom knowing we can ultimately hinder and limit their understanding. We need to know what they already know to not bore them. (Savannah, blog post)

> It really had not occurred to me that, as our professors preached, if we did not take the time and effort to fully convince (not just teach) a student of the truth of the matter, they would mock knowing and understanding the real facts, and comfortably return to their misconceptions afterwards. (Stella, blog post)

> I do, however, feel as though we had a good, interactive lesson with the fourth graders. Even though this material will not necessarily be expanded upon in fourth grade, we continued to address misconceptions they may have had from earlier grades as well as help lay a foundation for fifth grade teachers they have next year. The students who were on task were truly that, on task and interested in making the parachute slower. (Gabriella, blog post)

While PS-ESTs did allude to strategies in their narratives, these were not further unpacked with respect to student misconceptions. These strategic allusions seemed to focus on knowing and being aware of student knowledge through assessment or time with the students rather than a redirection of student knowledge towards a deeper conceptual understanding. Where an expectation for specific approaches was both desired and reasonable, only general statements were made. For example:

> The importance of misconceptions in our teaching is an appropriate topic for this common blog because I do believe that it extends across all content areas -- literacy, science and math. The reason it is so important to be aware of misconceptions, in my opinion, is to understand where students' thinking is coming from and plan our teaching accordingly. By this I mean, we can be prepared for the levels of experience that our students have had with a certain

topic we are planning to cover, and be purposeful about how we plan to address the 'misconceptions' and 'preconceived notions' that our students have towards a certain subject. (Zoe, blog post)

PS-ESTs recognized that students needed to acquire science content knowledge. Their acknowledgements of this need occurred through the use of purported employment of beneficial practices to both reinforce current knowledge and encourage the learning of new ideas. While the use of methodology was important for knowledge gains, the PS-ESTs also reflected on why knowledge was valuable to the development of their students. This recognition of the utility of science was present in all blogs.

The utility of science for student development. PS-ESTs saw content knowledge as foundational to their practices because of its value to student learning. This worth extended beyond a fundamental importance of knowing content for content's sake, though there were instances of PS-ESTs placing a priority on the inherent value of the content. However, these priorities were often couched in PS-ESTs' recognition that content knowledge and practices associated with it were valuable beyond learning outcomes typical to the academic classroom:

> I also think it is important that all of my students learn that science is everywhere! Even though it [is] not very prevalent in the classroom I want it to come alive all around, including outside of the classroom. To me, science is exploring and discovering how things work. (Chloe, blog post)

> About discourse and argumentation…it strengthens students' understandings of their own choices and processes. It also allows many ideas to be shared and

> combined, forming stronger defenses for answers and allowing several mindsets to work together. It is a skill that all students will benefit from during school but also later in life. (Hannah, blog post)

> About classroom science… Depriving students of exploring their questions while in school is a disservice to them. Not all children have ways that they can explore their own curiosities so it is up to us as teachers to help them explore the world around them. (Evelyn, blog post)

The utility of science was prioritized by how it could aid students' future endeavors through the development of specific skills. PS-ESTs saw the development of abilities connected to science learning as beneficial both academically and beyond the classroom. For instance, posts were made that acknowledged how learning associated with science could "improve student's reading, writing, and math abilities" or enable students in making "predictions and explain their thinking which are both skills that will continue to be used as they get older" (Ava, blog post). Some posts alluded to the importance of science for academic development that would occur as students progressed through different grades: "Also, if it is not addressed in these early years students who are interested in scientific topics will not be given the opportunity to explore their interests" (Savannah, blog post). These posts placed an emphasis on a good education being such because it includes science whereas the absence of science indicated an incomplete education.

While the goal of methods courses was the development of elementary school science teachers, what led to this development was of importance. Development is often marked by dissonance, instances in which what is expected and what transpires do not correspond.

Dissonance was indicated in PS-EST reflections that featured contrasts in their own expectations, those that were important for science learning, and what transpired in the authentic learning space of the local elementary classroom.

Comparisons and Dissonance

A component of perceptual control theory involves comparisons that are made by processing external inputs related to a role and comparing them with personal expectations (e.g. identity standards) for the role. A result of these comparisons can be either the achievement of a desired outcome viewed in relation to personal expectations or varying degrees of dissonance that are generated when personal expectations and outcomes do not align. In these moments where alignment is not attained, varying degrees of dissonance occur. Ideally, this dissonance leads to a shift in perspective that generates long-term adjustments to teaching practice. This dissonance can also produce awareness of changes needed for successful praxis. The following findings were classified as types of dissonance.

Adaptations of Practice. Adaptations of practice are described with two parts. They are the PS-ESTs' consideration of contemporary experiences and reflections on how they would alter what had previously occurred. These adaptations could be a synchronous decision made to address an immediate need or an asynchronous reflection on how to improve future iterations of a practice. These adaptations were generally focused on logistics of lessons and would sometimes involve content or content-efficacy concerns. Synchronous adaptations were viewed as *simultaneous* while *future* iterations were categorized as representations of contemporary lessons and how they would be utilized for future practices.

Simultaneous. The PS-ESTs rarely referenced a synchronous change to practice. In some situations this occurred because the activity mentioned involved equipment or materials failure: "[T]he charts did not print out correctly…Because of the limited amount of charts, we had to take time to have the students draw charts on the back of the worksheet" (Savannah, blog post). In cases involving such changes, the PS-ESTs described the effort as beneficial by addressing how the change influenced the activity. In other cases, the PS-ESTs did not address new strategies or approaches, often giving a description of what transpired in terms of what did not work in the lesson. In Gabriella's excerpt, a logistical issue was at the forefront of the PS-ESTs' thoughts about a particular activity. Both PS-ESTs sought to re-emphasize content and diminish the "distraction," but saw the logistical challenge produced by student competition as an issue rather than an opportunity to enhance what was going on.

> In addition, we split the table into two smaller groups and had each one make a parachute to be modified. Well, mistake. It turned into a competition between the groups of who could make their parachute slower, despite urging from Deanna and me that the important thing to remember was what we are altering and how it affects the rate of falling. (Gabriella, blog post)

Adaptations made to activities revealed some ambiguity in the PS-ESTs' beliefs about teachers' roles. In reflections the PS-ESTs often alluded to a desire to allow for and embrace unexpected outcomes. As discussed in the findings related to the teacher agency theme, this perspective was based on beliefs that the teacher was a facilitator who encouraged student ownership of learning and activity. However, the PS-ESTs did not maintain a facilitator's perspective when faced with unexpected or unplanned outcomes. Multiple posts revealed that the PS-ESTs preferred direct intervention instead of mediation of student learning and activity through subtle questions or nuanced changes to an activity. An excerpt from Savannah's blog reveals this tendency: "We had intended for the students to make the changes, but it worked out that we could maintain consistency only if we made the modifications." Savannah and other PS-ESTs often approached activity and student learning with a student-centered approach in mind, yet frequently showed a preference for direct instruction when unexpected digressions occurred in lessons. Unexpected digressions produced dissonance with respect to the PS-ESTs' beliefs about their roles as teachers and their actual performance as teachers.

Future. The PS-ESTs' reflections on contemporary experiences produced considerations of future practices. These reflections often included an evaluation of self and a consideration of what was successful in a lesson, along with some thoughts toward integrating ideas generated by experiences. These adaptations included allowing more opportunities for hands-on practices, setting specific, observable learning expectations for student outcomes, and effective use of specific methodologies (e.g. scientific method). For example:

> One thing we could have improved on was giving more clear instructions. The students wanted to take almost a half-hour to construct their first parachute attempt. Next time, Sarah and I will give the students a time line, so they aren't taking more time than needed. (Madison, blog post)

> To assure that all my students are learners and thinkers, not just current-information-absorbers, I will constantly dig deeper and have students make connections to their experiences and prior knowledge as much as possible by using probing questions and thought starters/modeling. (Stella, blog post)

> The experiment went very well logistically, but I think we could have asked harder questions with this group of students. I think next time, we will be prepared with a harder set of questions that really dig in and make the students make connections with other concepts. (Brooklyn, blog post)

Another component of future adaptations involved student engagement. In reflections that featured adaptation, the PS-ESTs valued student input and student responsibilities (e.g. division of labor in group activities). For example:

> In my future classroom, I would want to identify the strong ways in which each student comprehends, expresses themselves, and stays engaged in learning. (Stella, blog post)

> I think that one way I can incorporate elements of UDL [Universal design for learning] is by giving kids the opportunity to use manipulatives, incorporating literature, and more. (Samantha, blog post)

Adaptations of future practices illuminated PS-EST tendencies to focus on components of learning not specific to content or the students' development of conceptual understandings. Instead, the PS-ESTs emphasized the development of different perspectives. They deliberately lessened content focus because they desired to encourage marginalized students, recognizing disparities such as those associated with gendered norms and tendencies, or issues common to those who had lesser numbers of life experiences that informed perspectives.

> Although the girls talked a little bit more this time than last time, it was evident that they were holding back because they felt like the boy in their group knew more about it than they did and even when directly questioned, they would begin to respond, but more or less, pass off the question to the boy in their group. This causes me to wonder what would happen if we grouped based on gender, boys and girls. Would the girls perk up and work together or would they work at a slower pace and watch the boys on the other side of the table to replicate what the boys do? (Sarah, blog post)

> A child might have misconceptions about how boys and girls are supposed to act. For example, in my classroom we had a boy saying that boys cannot wear pink because it is a girl color. My teacher and I, along with a few other students then explained that boys can wear pink just like girls can wear blue. I then explained that I wear blue all of the time, one because I like it, two because I go to UNC, but I am not a boy. (Evelyn, blog post)

Overall, the PS-ESTs focused their reflections on adaptations designed to make science fun while also encouraging comprehension. These adaptations might involve the use of manipulatives or varied, student-centered activities, the primary goal being to expose students to multiple representations as building blocks for comprehension. A common trait of these adaptations was efforts to encourage interactions among students, the use of accountability talk, and discussion facilitated by the teacher. These student interactions could involve a whole-class or small group.

Science will be a fun and engaging time of the day in which students look forward to. After the experiment, the class will come together and discuss what they learned and tie it to what we have done in the past. I will have books related to the subject in the book display so the students can read them during free time. (Brooklyn, blog post)

It is necessary for us as teachers to be able to identify in which environment students can succeed--individual conferences with a teacher, partner work, small group or whole group discussions are all different scenarios that students should be able to talk but some students are more comfortable in some over the other. This is why it is important as a teacher to provide opportunities for students to engage in each of these types of discourse and argumentation. (Zoe, blog post)

Consistent throughout the PS-ESTs' blogs and comments was a high valuation of inquiry-based learning. In valuing this type of learning, the PS-ESTs sought to minimize worksheet-based science by encouraging student discovery through engaging questions, hands-on experiments, and research projects. They highlighted the previously mentioned as essentials in their future practices.

I feel that in some ways the FOSS kit is a good science curriculum that lends itself to further investigations and exploration to better understand the material. I was impressed by the level [of] experimentation covered in the curriculum and the amount of additional resources available online....Positively, many of the activities can lead into connections to other

> subjects that could at the same time build understanding of the science materials. (Savannah, blog post)

> In my classroom, I intend to present the content in a variety of ways to identify with each student's learning style. I will prepare visuals and demonstrations, as we all know modeling processes is very important, whenever I'm teaching. This way, students have both an audial and visual source of the information. Furthermore, during activities students will have chances for tactile engagement with content, like using manipulatives in math. Every student is receptive to knowledge; it's just takes finding their learning style and addressing their needs. (Reagan, blog post)

A final component of future practices was the integration of knowledge about students into the teaching of content. The PS-ESTs sought to mirror aspects of students' "real life"; emphasis on the students' home life produced a frame of reference for comprehension or illuminated reasons for students' prior conceptions.

> Using Legos in the classroom can help for students to connect their learning between home and school. Many students use Legos at home to construct various machines and buildings. However, they may not be realizing how they are using different aspects of the scientific method or how they build certain things with a specific goal in mind. (Ava, blog post)

> A huge part of being a teacher is knowing what to expect from you students. Students are coming to us from different cultures, schools, teachers, and homes. They all bring different ideas about concepts to the table. We

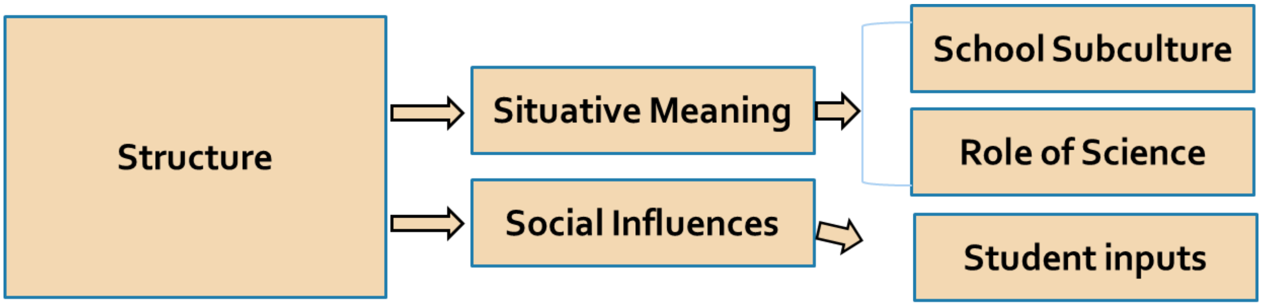
> cannot always pinpoint where these misconceptions started, but it is our job to know when to expect them and how to confront them while planning our lessons. (Abigail, blog post)

References to home and school indicated that the PS-ESTs were developing an understanding that they would need to recognize how extracurricular influences shaped student conceptions and comprehension of content. Based on the varied reflections, two take-aways materialized. First, the PS-ESTs saw the importance of knowing their students beyond the classroom setting. Second, this knowledge could and should be utilized to guide classroom practices.

This section of the findings addressed the first research question which featured the PS-ESTs' beliefs and perceptions, dimensions of the PS-ESTs' identities as expressed through blogging. The themes that emerged from the data highlighted the PS-ESTs' identities in terms of teacher agency, prescriptive acts for student benefit, and comparison and dissonance. Teacher agency was influenced by beliefs and experiences; beliefs based on pre-conceived notions of teaching an experiences that illuminated preferences for future practices. Prescriptive acts include ideas associated with what the elementary-aged students know, challenges to their learning and the benefit of science. Comparisons and dissonance illuminate ideas associated with PS-EST adaptations of practices, either in their immediate context or future ones.

Structure

Figure 4.2 Structure



Structural findings were viewed as influences on the PS-EST's activity or thought processes that were beyond the PS-ESTs' control or, at most, minimally influenced by the PS-ESTs. Structure represented the second tenet of PCT that focused on the integration of contextual inputs as the individual enacted a perceived role within a context (e.g. PS-ESTs in academic courses/elementary classrooms). These findings addressed the second research question that guided the study. The structural findings addressed what influenced PS-ESTs and how they processed and utilized these influences.

Though classified as structural, this dissertator made a conscious effort to remember that blog posts were mental representations of experiences conveyed through written expression. These representations were generated with the PS-ESTs' perceptions likely shaping the content. With this subjective influence in mind, the analysis of the posts required the identification of the objective, external influences that were featured. To understand structural influences, analysis required examining the posts or comments infused with the PS-ESTs' own perspectives and discerning what was revealed about the structure. These findings were framed as structural findings and included two themes: situative meanings and social influences. Situative meanings included two subthemes: school subcultures and the role of science. Social influences included inputs related to the elementary-aged students with whom the PS-ESTs worked. These findings captured experiences that were associated with schools (e.g. curriculum, methodology, CT, etc.), students who were the intended audiences for teaching, and contextual agents (e.g. cooperating teachers, University instructors).

Situative Meaning

Theoretically, learning occurs in a context that assigns meanings to roles and tasks. Because learning is embedded and inseparable from the individual's situation and activity (Wenger, 1998), any comments produced through blogs produced insights into the multiple contexts in which the PS-ESTs were situated. Blogs revealed facets of the culture and activity of prominent contexts (e.g. local classrooms, academic classrooms). These facets were construed as mediating factors that could influence the identities of PS-ESTs. Within the data, two primary influences materialized; they were the school subculture and science content that served a specific role in defining what activity was going to occur.

School subcultures. The first set of contextual influences that were beyond the control of PS-EST related to the teacher preparation experience. Within the theme of school subcultures were two distinct sub-themes. The first was university influences from the undergraduate classroom. Within the sub-theme of university influences were several distinct groupings. They were: 1) methodologies associated with specific approaches to teaching science; 2) field experience influences which embodied authentic teaching in a local elementary classroom; and 3) curriculum which included acknowledging the value of and types of curriculum, as well as its limitations or benefits. The second sub-theme perceptions of historical classroom experiences was associated with experiences from the PS-ESTs own educational journeys. These reflections highlighted facets of classroom practices not specifically associated with undergraduate coursework that shaped how the PS-ESTs perceived their own or the teacher's role, in general.

University influences from the undergraduate classroom. A bulk of PS-EST posts associated with field experiences or the academic context were dedicated to describing what transpired over the course of a specific lesson or component of academic coursework. These descriptions were presumed to be important because they indicated something of value within an activity or the context that was being described. When course content or a component of field experiences was revealed, these reflections were valued because they illuminated something about how PS-ESTs processed external inputs.

Methodologies. The PS-ESTs recognized the role of methodology in the classroom. Though these methodologies varied, they consistently involved recognition of student differences as a key component of the learning process. Practices mentioned included universal design for learning (UDL), understanding by design (UD), or discourse and argumentation. The use of methods also included less-defined ideas such as the use of experimentation or hands-on activity. Common to all described methodologies was science learning that utilized procedures to accomplish specific learning outcomes, inquiry-based practices, and a certain amount of "organized chaos." These methodologies were also associated with classroom environments that emphasized good relationships among students, between students and teachers, and other individuals who might work in the same spaces as the students and/or PS-ESTs.

> The strategies of discourse and argumentation serve not only to promote inquiry based learning, but can teach students how to effectively and respectively argue for their cause. (Gabriella, blog post)

> I also agree that a classroom centered around student discussion would require careful setup, but is totally worth it. (Adeline, comment on Stella's blog post)

The focal point of this university-based influence from the classroom was the use of methodologies that serve a two-fold purpose. They are: a) opportunities for science-based inquiry; and b) collaborative scaffolding that encouraged student interactions through content-specific investigative inquiries (e.g. parachute design, properties of matter). These methodologies required participatory learning and indicated that divisions of student labor were valued. These methodologies influence PS-EST preferences for interactive classrooms.

Field experience influence. Field experiences included the integration of methodologies with authentic learning experiences in a school setting. While part of the academic coursework, the context was the local elementary school rather than the undergraduate classroom. Field experience reflections indicated important roles for content and methodology referencing what occurred, what was ongoing, or what was about to happen in the local school. These posts involved students, but were different from a specific focus on methodology because they referred to how the methodology was used with students. For example, "We have focused on differentiating using whole group lessons vs. my CT uses discourse and argumentation, which is a way to integrate scientific practice into student thought processes and communication" (Lila, blog post).

These coded posts also revealed field experience influences associated with the cooperating teacher. They included the PS-ESTs' observations of established practices within the local elementary classroom.

> I have seen discourse in every single discipline in my classroom. There is a 'share' component to every lesson that my cooperating teacher plans… My cooperating teacher models conversations to her students as to what proper conversation will look like. She additionally creates posters titled 'How to Talk About Math' and 'I've turned to talk, now what?' for students who need guidance on how to have a conversation. If we teach students these skills now at a young age, they will have more success in the future when it comes to articulating thoughts and reasoning through their thinking. –Zoe, blog post

Zoe's post referenced a specific methodology, discourse and argumentation, offering a tacit acceptance of the practice. Zoe's frequent acknowledgement of the practice and specific strategies associated with it in a local school setting represented a clear example of structural influence generated by her CT. In contrast to the positive sentiments related to the influence of the cooperating teacher shared in Zoe's post, others conveyed concerns about the emphasis placed on science in the elementary schools. In the example below, Chloe reflects on the lack of science and the apparent, deliberate effort of the CT to focus on other content areas. Chloe condemned this lack of emphasis and inclusion of science. As implied in Chloe's statement, the practices of the teachers seemed to reinforce Chloe's view that science should be included,

> It appears that science and social studies take the back burner to math and literacy frequently. I'll admit this does upset me that the classroom teachers do not try harder to implement these things more in their classrooms. Not only does my cooperating teacher skip those subjects occasionally, but she

> teaches from a PowerPoint and requires the students copy definitions before moving in to actual content and material. –Chloe, blog post

Field experiences also include aspects related to the curriculum, but the influence of the curriculum went beyond the field experience.

*Curriculum***.** The definition of curriculum depended on the audience. PS-ESTs' posts revealed that curriculum, the textbook as one form, was a supplemental component of school practice recognized more for being physically cumbersome than a textbook with beneficial knowledge. "I feel that textbooks can be supplements to back up concepts and lessons that are taught. They should be used as a reference guide" (Liliana, blog post), or "Texts are heavy and weighed down with overwhelming amounts of information. So much of what is in textbooks goes beyond the necessities and so much is frustrating (Savannah, blog post)." PS-ESTs, when not referring to a text, preferred open-ended learning, but often dissociated such practices with the concept of curriculum. For example:

> I also think that science in elementary school should follow students' interests more than a curriculum. If a student comes in asking a question about something he/she noticed, then the teacher should use that to branch into a science lesson because it encourages children to be inquisitive about the world around them. (Hannah, blog post)

The curriculum-related influences also included explanations of kits (e.g. Full Option Science System [F.O.S.S.]) or references to already established standards such as those found in Common Core, Next Generation Science Standards (NGSS), or the American Association for the Advancement of Science (AAAS). The PS-ESTs perceived that curriculum was dated and missing components, causing it to lack twenty-first century appropriateness. "The kit was made in 1998 or 1999 which means that technology isn't incorporated and the core standards or even new North Carolina Standard Course of Study [NCSCOS] is not included" (Savannah, blog post).

Though PS-ESTs acknowledged limitations with curriculum, they also generated solutions to challenges associated with it, indicating how this influence shaped their ideas of science teaching. For example, one PS-EST suggested:

> An even better solution would be for the textbook companies to make textbooks without the useless "fluff." Books would cost less money and would actually be used to their entirety. Also, all the lessons and materials are already made and mass-produced and therefore are not catering to the individual students in our classrooms today. (Lila, blog post)

For curriculum to be worthwhile, PS-ESTs posited two traits. First, the curriculum needed to fit with a variety of teaching philosophies. Second, the curriculum needed to incorporate real-world connections, making the content relevant to the students learning it.

> I also agree that the scientific method should not be the central focus of elementary science curriculum and instruction (besides, isn't the scientific method getting a little outdated? Let's think outside of the box!). Science is not static; it's dynamic, and so shouldn't our methods of teaching also be DYNAMIC?! (Zoe, blog post)

PS-EST tendencies such as Zoe's also presented a unique perspective that required diminishing acontextual practices such as national standards in favor of contextualized approaches that relied upon the local classroom to define and shape what was learned. The connecting of content to the real and daily life of students produced two important approaches to curriculum and its use. First, student-centered practices would minimize the use of information disconnected from the students' lives while also challenging historical practices such as standardized assessment. Second, it would empower the teacher to decide what should be taught in the classroom.

> That being said, I feel that textbooks can be supplements to back up concepts and lessons that are taught. There are some textbooks that are very useful and provide beneficial knowledge and examples. They should be used as a reference guide. (Abigail, blog post)

When acknowledged as more than written or published text, curriculum involved activity and cross-curricular practices. Cross-curricular emphases indicated PS-EST expectations and presumption that curriculum could be adapted to the needs of the local classroom. In reducing their comments, the PS-ESTs took an evaluative stance indicating that curriculum was a hindrance to teaching science in the elementary school because of its disconnect from the local context.

Perception of historical classroom practices. One of the strongest influences on the PS-ESTs was experience. Experience shaped perspectives of content and roles, and so descriptions or reflections involving the PS-ESTs' own educational histories were utilized to understand the PS-ESTs' perceptions of science, both teaching and learning.

One of the interesting revelations was a dichotomy involving the use of books and hands-on experiences. The PS-ESTs acknowledged that their own teachers valued hands-on experiences yet frequently tested or quizzed from books or other texts. "While most of my science classes were hands-on every day, most of the information for our tests and quizzes came from the book” (Liliana, blog post). The PS-ESTs also acknowledged that the many hands-on experiences produced limited retention of content knowledge, minimal comprehension or vague remembrances of what did occur. For example:

> I'm with you- a lot of the stuff I remember about science in elementary school is based on the activities we did (like when I got to raise an egg into a butterfly, but mine died before it came out of its cocoon). But, like you, I didn’t always gain the comprehension I needed from doing those fun experiments. (Caroline, commenting on Chloe’s blog post).

Like Caroline and Chloe, most PS-ESTs acknowledged that their own science education relied heavily upon hands-on experiences, indicating a value for constructivist practices. Both contemporary and historical practices included in the PS-ESTs’ blog referenced these practices (e.g. inquiry and hands-on learning). The PS-ESTs also used what they experienced to shape how they defined the facilitator’s role. However, their reflections indicated a preference for activities with very specific outcomes that required teacher-directed activity associated with knowledge acquisition versus participatory learning.

PS-ESTs perceived that good practices involved a balance between lecture and hands-on activity. The quality was based on learning that involved personal ownership of the process and experiences that were remembered in a positive light. “Many of my favorite science projects were integrated into every other subject that we were learning at the time” (Mila, blog post), or

> My experiences in science stand out to me because they have a fun and interesting outcome. Learning how to construct a volcano and then seeing it actually work were awesome experiences that I want to share with my future

> students. I love fun science experiments that really have a purpose behind them. (Brooklyn, blog post)

> I think what made this experiment such a memorable one is the fact that I had ownership over my rocket. I got to decide how I wanted to decorate and construct my rocket. When it came time to launch our rockets, I remember feeling so proud. It didn't matter how high my rocket flew at the moment, I just remember being thrilled at the chance to see my rocket soar. (Samantha, blog post)

These remembered experiences stood in contrast to book learning or busy work, which the PS-ESTs tended to disdain. Though their comments consistently invoked the idea that good science involved activity, cool experiences, and fun, the PS-ESTs also acknowledged that science was limited because of a general lack of importance placed on it by their teacher, overemphasis on the use of texts, or lack of stress on retention.

> It is somewhat sad to say some of my earliest memories of science were when I was in high school. There are those few, distant memories of some science encounters in elementary school, like when we grew a plant in a sandwich bag and made dirt pudding to eat (while diagramming the layers of earth). It seemed like science was learned whenever and wherever it could fit into the curriculum and our school day. (Gabriella, blog post)

> I remember as a kid I was not exposed to this type of teaching. When I was in elementary school, we followed a strict "whatever the teacher says goes" rule.

> The classroom was much less discussion and inquiry based. I think that the lack of inquiry in my past science classes truly hindered my understanding of science topics. Science without the inquiry aspect was not exciting and fun for me. I spent way too much time buried in a book that I never got the chance to see how cool and how applicable science is to real life. (Samantha, blog post)

In other posts, PS-ESTs acknowledged that the classroom environment played a different role. Instead of a focus on learning, the classroom was a place that looked at learning holistically.

> However, there were a few classrooms in which the teacher created an environment that made me feel comfortable enough to come out of my shell and share my ideas with my peers. In these classes I would raise my hand multiple times a day, and even if I was wrong, it wasn't a big deal. (Mila, blog post)

Mila's memories did not involve content, but an emphasis on the influence of a given teacher. These teachers were usually recognized for their ability to generate ideal environments that often included an opportunity for a hesitant child to participate or the integration of science with other content areas.

PS-ESTs' perceptions of classroom practices varied. In some cases, unique traits were revealed, while others represented general ideals about the classroom environment. Through historical perspectives, the PS-ESTs revealed that experiences were formative and that how they approach the teacher's role consisted of a compilation of both positive and negative components of the classroom.

Role of Science. Theory notes that the fluidity of identity is the result of context. While the concept of context encompasses multiple variables, science content necessarily occupies a position of prominence. Given its role in school curriculum and the explicit focus of the methods course on science, observations associated with the role of content constituted a unique theme that included the sub-theme, perceptions of content or content roles. This sub-theme included ideas associated with the merit of science as a stand-alone content area for elementary schools, issues with how it was prioritized, and, the benefit of science for development beneficial skills.

***Perceptions of content or content roles*.** The PS-ESTs' posts implied that content was an important influence on practice because it was used to define expectations and generate ideas for learning activities in the classroom. The PS-ESTs had perceptions of content that included its appropriateness for elementary grade levels, recognition that science utilized multiple disciplines (e.g. math, literacy), and that science integrates data representations through a variety of formats.

> Today, it seems that elementary science has become an integral part of the curriculum. Although science and social studies are typically on a rotating schedule, I have seen science integrated into reading and writing activities. (Madison, blog post)

> My perceptions of science in elementary schools today are, unfortunately, limited. This is not just due to the fact that in our past semesters we have only gotten to spend 2-3 hours per week in schools. It is also because science instruction is limited nowadays. Often, its importance is not seen and it is not

> state-tested; therefore, it is not taught as often. Science must be taught because a) it's fun (b) it teachers critical skills (c) it encourages students to be curious and follow through with their curiosity. (Stella, blog post)

> I think the idea of creating and implementing science standards is great and will strengthen students in their other academic subjects as well. If a student can make a table for data in science class, then he should also be able to make a table in math class. If a student can explain her observations during a science experiment, she should be able to write a how-to paper. (Addison, blog post)

Madison's post notes her observation of the prevalence of science in the curriculum while Stella's post illustrates both her own identity standard (e.g. "its importance is not seen") and the reality that science is not prevalent enough in the elementary school setting. Her perspective of content recognizes adverse influences on its use, which minimize the role of science as an appropriate part of a child's development. Addison's quote also indicated an identity standard and an important component of what science could do, develop transferable skills. While Addison primarily focused on data representation, she also alluded to the ability of science to develop elementary students' communicative skills.

Science was viewed by the PS-ESTs as a progression that prepares the child for the future by producing a variety of skills that included, but were not limited to, critical thinking and acceptance of error. In some posts, the role of science was influential for future use of it in the classroom.

> I never took an astronomy class, so elementary school was the only time I've ever been taught about phases of the moon and constellations. In 9th grade biology I learned about animals to an extent, but I didn't get the hands-on experiences that FPG had to offer. I didn’t get to go to the beach with my class to actually collect and study water or dissect owl pellets to discover what their diet consists of. Taking science out of the elementary curriculum would be depriving children of experiences that could shape their futures and interests. (Mila, blog post)

> I agree with you that elementary science is about building the base for their future science learning in middle school in high school. If the students do not learn the basics in elementary school, they will be caught off guard as they go into middle school and high school sciences. I also agree that elementary school is the time for hands-on experiments. While you continue to do experiments in middle school and high school, I remember doing the largest amount of experiments in elementary school and it really got me excited about doing science as I got older. (Jasmine, comment on Madison’s blog post)

Mila’s post indicates that a tendency exhibited throughout her education minimized science, though her reflection indicated a willingness to contend against such a trend in her own practices. Jasmine’s comment spoke of the value of science for student development; the important influence of her own experiences in elementary school was the impetus for her valuing of science.

Social Influences

A second category associated with the context that shaped the PS-ESTs activities included variables associated with different agents within the context. Based on the volume and content of the PS-ESTs' post, it was clear that the experiences of the elementary-aged students played a role in determining instructional strategies or how the PS-ESTs would approach classroom instruction. Such findings were labeled student inputs because they were external to the PS-ESTs and related to the elementary-aged students. Student inputs included approaches to pedagogy, philosophies for student activity in the classroom, and outcomes generated through various learning activities.

Student-input. The PS-ESTs recognized the differences in knowledge capital generated by the diversity of learners and their experiences. Either could influence the pace and style of classroom learning and even lead to underestimations of student ability. "I think it is really important to recognize where a misconception comes from like you mentioned. It is challenging to debunk a misconception that has been ingrained in a child's head due to their culture or their upbringing (Lauren, comment on Evelyn's blog post)." These moments of dissonance had various origins, including student cultures or learning styles, yet were important because they represented indicators that the PS-ESTs would value student needs or preferences when teaching or preparing to teach specific content. Such posts often represented a synthesis involving the established practices of content and the sociocultural backgrounds of students, an intersection among components of school cultures and the identity of the students that attended them. The idea of student-centered learning influenced the selection of instructional approaches. For example:

> Not only does UDL encourage different sensory stimuli for multiple learning styles, it also emphasizes the importance of tiered instruction and choice. Students need options so they can choose what they are most interested in and capable of accomplishing, while still keeping them focused on the content of the lesson. (Reagan, blog post)

The type of methodology used could vary, yet the PS-ESTs' posts revealed tendencies to focus on those methodologies that allowed for individual difference or group-based activity (e.g. community-based learning or experimentation)—not so much for the content, but for what the practice afforded for student engagement. This allowed learning to be designed with the student in mind while also allowing optimal outcomes with content—though these outcomes were not explicitly stated beyond the frequent use of engagement and excitement to describe student learning.

Also of importance was how knowledge was acquired or presented. The PS-ESTs preferred hands-on practices, minimal text use, contextualized outcome objectives, and student-centered practices with nominal teacher control or intervention. "I will try to use it [discourse and argumentation] more often than not so that students get to learn in a student-centered classroom instead of one in which the teacher just talks at the students" (Madelyn, blog post), or "listening to a teacher talk is NOT the right way to learn. Sure, it's fine in moderation and is definitely necessary at times, but I don't think that this is the best learning style for the students in our class this year" (Layla, blog post).

The rationale for student-centered practices was that students learn through interactions with other students and the creation of their own learning experiences. Also acknowledged by the PS-ESTs was a partiality for knowledge that students could embrace beyond the classroom because the knowledge was contextualized and relevant.

> You need to pull in outside material to make the unit more relevant for the students in your class. Otherwise, how will they know that it's important to learn and applicable to their lives? Also, tying in information that is relevant to them will improve their abilities to retain the information. (Hannah, blog post)

> I see ways to relate science to everyday life and ways to get students to really connect with science topics that once seemed irrelevant to them. However, unlike today, I remember feeling overwhelmed by science in elementary school. Unfortunately, I never saw science in my everyday life and I always felt very detached from it. (Samantha, blog post)

The engagement of students in content required an invocation of student curiosity sparked by the unknown and opportunity to embrace the world through hands-on activity. By connecting this natural curiosity and students' love of knowledge, science became relevant and engaging; the biggest challenge was what exactly the goal of the activities was. What should be learned or privileged information was not explicitly stated by the PS-ESTs.

Student outcomes with respect to science seemed to be important to the PS-ESTs, but were not clearly defined. These outcomes could include engagement of students who were limited by real-life challenges such as language proficiency and stages in student development (grade level practices), or an expected, specific learning outcome (e.g., understand air resistance) for a given activity. The constants included students engaged in learning and a need to differentiate expectations according to grade level. PS-ESTs frequently stated that older students were more competent with science activity and comprehension of concepts and required less scaffolding then their younger counterpoints, even alluding to different forms of pedagogy for the same experiences.

> I was excited to have a chance to be with older students for this lesson because I find that I tend to like teaching the older grades. While I do love the younger grades I find that specifically in grades like kindergarten I get bored with what the students are doing. I was extremely excited to see what these fourth graders knew compared to the second graders. (Evelyn, blog post)

> On Tuesday we taught in a 4th grade classroom at Carmichael Elementary School. We taught the parachute lesson just as we had taught to the 2nd graders a few weeks ago. We were told to adapt this lesson to 4th graders but I was a little unsure how to do this. Nothing in the 4th grade science standards related to air, qualities or air or air force and because I haven't spent much time in upper grade classrooms, I wasn't sure how much these 4th graders would know. (Lila, blog post)

> The parachute lesson definitely went a lot better with the older kids, in my opinion. They were able to design, test, and record their data with very little hands on help from Hana or I. We really just discussed air resistance with them a little bit and then let them go. (Grace, blog post)

Student social profiles were also influential; student learning outcomes were shaped by past experiences as well as recognition of gender-normed tendencies.

> My last critique relates to a classroom discussion. Dr. Taylor mentioned that if girls are not engaged in science by third grade they are statistically proven to feel unmotivated to enjoy science or ever pick a career in science. (Chloe, blog post)

> Although the girls were engaged and excited in the experiments, they spent more time processing the information than the boys did and as a result, weren't as vocal because the boys always answered first. It is critical that students have the opportunity to share their perceived understanding of a concept and although the girls did have a chance to say a few words about each experiment, they were definitely overshadowed by the boys. (Sarah, blog post)

Based on evidence presented throughout the PS-ESTs posts, student prior knowledge was a crucial component of student outcomes, indicating that addressing conceptions was important to student learning. Prior knowledge was based on experiences and early exposure to ideas associated with science and could be self-generated explanations or conceptions presented through formal education. This emphasis on prior knowledge was considered in anticipation of preparing students for immediate or future academic practices and the development of life skills versus specific conceptualizations associated with any one content domain of science.

> In science, we've seen videos where it is important to open a lesson with discourse. That way it engages the students and prepares their minds for further exploration. It also gives the teacher an initial assessment as to how students think and what their prior knowledge, or misconceptions, might be. (Hannah, blog post)

> Students need to understand scientific foundations, so they can build upon this knowledge later on. For example they learn the basis of plants and growth in 3rd grade, but in biology they will go in depth about photosynthesis and transpiration. If students do not know the basic facts about plant growth, it will be more difficult for them to understand this later on. (Chloe, blog post)

With respect to students, PS-ESTs seemed to place an almost universal emphasis upon student development of relevant skills, engagement with activity, and acceptable engagement with other students during the course of classroom activity or learning governed by a specific methodology (e.g. discourse and argumentation). In contrast, there were rare instances when a specific goal of content comprehension was stated.

Interactions

PCT postulates that identity includes the internal dynamics of individuals that operate within specific roles and the integration of contextual inputs as the individual enacts these roles. Agentic and structural themes that emerged from the data produced information about different facets of individual identities and the contexts that influenced them, respectively. The agentic, the frame of personal agency and its corresponding themes and subthemes, included the activity and thoughts of the PS-ESTs as they dealt with their surroundings and inputs from themselves or others. The structural, the frame of structure and its related themes and subthemes, were influences that were beyond PS-EST control, acknowledged aspects of contexts that were minimally influenced by the PS-ESTs' actions or responses. Interactions are the influences generated by interfaces within the PCT framework that cannot be labeled as personal agency or structure.

Initially, the PS-ESTs' blogs and comments were examined with a primary emphasis on finding and analyzing interactions among the PS-ESTs. However, minimal reflections and comments among peers produced a need to focus elsewhere. Peer interactions that occurred through the blogs were evaluated when they arose, but more prominent interactions were present. These interactions were captured in the theme developmental dyads.

Figure 4.3 Interactions

Developmental Dyads

Based on the importance of the individual and context in the literature on identity, initial analysis of the PS-ESTs' blogs was intended to identify components of the individual and of the contexts, associated in this dissertation with personal agency and structure, respectively. Using interactions as a frame for the data, personal agency and relevant structures were considered in tandem and resulted in one theme, developmental dyads. Developmental dyads illuminated some of the interactions, either within the structure or between the individual and the structure, which had the potential to facilitate the growth of the PS-ESTs. The analyses revealed person-person interactions, exchanges among individuals within the physical space of blogging, and person-structure interactions. The person-structure interactions were mental constructions of the PS-ESTs; that is, the person-structure interactions did not occur in a physical space but, as expressed in posts, were contemplated by the PS-ESTs.

Peer Interactions. Given the design of the blog project to induce some form of peer interaction, the ideal was to generate person-person interactions. The aim was for these person-person interactions to occur through comments generated within the community of peers as they interacted through blogging. Research indicated that this structured community would enhance the methods and practices encouraged through academic classwork and field experiences (Anderson, et.al, 2013; Wall, et.al. 2014). When explicitly evaluated for their content, comments indicated that blogging produced minimal benefit through peer-mediated interactions. The results were categorized in one of three ways: 1) monologues; 2) question and answer; and 3) acknowledgement of peers.

As previously presented, the analysis of blog posts provided insights about the individuals and the contexts they experienced but the findings that pertained to personal agency and structure did not mean that interactions occurred—a primary focus of the third research question that guided the study. With respect to person-person interactions, the underlying question was whether or not the PS-ESTs were speaking with each other. The PS-ESTs' manners of discourse were reflective of a monologue in which the initial post and the comment were written with little or no expectation of feedback. Given the fact that the PS-ESTs were required to respond to two or more blogs each week as part of the classroom activity, this observed style was in contrast to expectations for dialogue that included a conversation between two individuals. The monologue indicated minimal peer-to-peer interactions.

The comments viewed as monologues resembled someone delivering a brief speech. Other comments departed from the monologues and included, question and answer responses, and a general acknowledgement of peers. Though infrequent—not all blogs contained them, these departures were valued because of the potential insights they produced.

The comments that were departures from the monologues could represent ideas associated with or not associated with specific prompts or specific ideas related to science teaching. They were not viewed as critical interactions that would benefit the PS-ESTs' long-term development or understanding of science teaching. If anything, blog posts and the rare comments attached to them were acknowledgement of a peer or the acceptance of a given method for student learning without explicit indications that the acknowledged practices or ideas would endure beyond the immediate context or situation referenced in the post or comment.

Monologues. One of the primary goals of blogging was to situate the PS-ESTs' learning in a new context generated by asynchronous interactions associated with the academic class. Ideally, these interactions would be formative, engaging each PS-EST through discussion about academic content (e.g. coursework-related ideas) and appropriate pedagogical practices. Unlike a typical dialogue between two individuals, the PS-ESTs' reflections were presented in a community setting with the hope that a genuine conversation would occur as a result of comments that sparked additional posts and/or discussion. However, what frequently happened were published monologues for an audience the author knew existed. For example:

My response to the board members would be that they are all crazy.

> Although I have realized that there isn't enough time in the day for everything, why would we get rid of science? Of all things, such as why would we spend 45 min learning how to sing in music and not about science? That absolutely baffles me. You make time and it's not hard to intertwine any subject into science. While doing science, have the student write responses or do experiments that involve graphing and numbers. Because science in practically everywhere, there is NEVER an age too young for them to start exploring and being introduced to science. Yes, the older you get, the more complex vocabulary you receive and the more in depth questions students are going to ask, but if they ask them, then they're ready for them. This prompt actually upsets me a little because science HAS been eliminated in some classrooms. So much emphasis is placed on reading recently that people do not understand that reading is not about worksheets and drills. The whole reason people read is to apply it to everyday life. Science IS everyday life, so yes, you do use tons of reading within this subject. Integration may seem like a scary word, but it is so easy to do (and maybe that's just the teacher talking in me). –Aaliya, blog post

Besides being an expressed monologue, posts such as Aaliya's also were eclectic in nature. They could be focused on the role of administration for one moment and then completely change focus to defining science before returning to the initial stimulus that produced the monologue. While seen as beneficial, posts were typically authored to express frustration or to just speak about a specific point of interest; as written, they did not generate interaction among peers.

Question and Answer. While the PS-ESTs' reflections were the result of prompts generated as a component of the methods course, the goal was to engender some level of communication that was an extension of ideas associated with a PS-ESTs' own unique reflections versus the satisfaction of an academic goal. Question and answer is one common communication pattern indicative of satisfying an academic goal; this question-answer interaction was largely absent from the PS-ESTs blogs. In evaluating comment-response scenarios from the 20 blogs, only three questions were asked with what was presumed to be genuine desire for feedback. These questions were: a) "Reagan, what program did you use to make this?" (Gianna, response to Reagan's blog post); b) "But my question is how would you choose a text which both contains the information that needs to be learned while providing stimulation and interest in the material? I think this is defined by a fine line and difficult to obtain" (Sarah, responsive comment); and c) "Now the idea of tackling an entire class of individual needs when teaching science seems overwhelming since our success was limited with only four students. Does anyone have suggestions or insights about this? Similar experiences?" (Sarah, comment based on response).

Acknowledgement of peers. One of the major interactions observed was peer acknowledgements. PS-ESTs posts acknowledged peers through brief comments, encouraged them through agreement and recognized effective uses of methods or pedagogical practices. However these interactions were brief and did not produce any form of dialogue. The pattern often observed with these comments was a lengthy initial post associated with a specific experience followed by a briefly worded statement intended to convey "I am here." Given the lack of specificity in these responses, they were seen as an informal greeting to be shared among peers. The following are examples of typical acknowledgement interactions:

> I love the bit about "current information-absorbers." Kids don't always need to remember every single bit of content, but the skills, processes and big ideas are what we want them to take away from our classroom. I also appreciate how your teacher doesn't make kids work with their elbow buddies if they don't want to! I definitely preferred working independently in elementary school so it's great when teachers are understanding about things like this. (Response to Stella's blog)

> I just commented on Sarah's blog about being a little nervous about implementing UDL in my class at Rourke Elementary. I absolutely love your teacher's goal about the 20/80 and I think that is definitively a way to start thinking about how to approach this. You also have awesome examples of how to use it in your classroom. I am excited to hear about how they go! (Response to Samantha's blog).

Both comments indicated that the PS-ESTs were attuned to what was referenced in the initial blog. The comments also seemed to indicate a general awareness of the practice being utilized. The limitation was that there was not an additional response from the blogger or a statement indicating a desire to inquire or learn about the practice in a specific context. Both comments were more substantive than a simple "I agree" but amounted to a lengthy encouragement—a phenomena that frequently occurred with comments throughout the blogs.

Student-content interactions

These interactions were not enacted by the PS-ESTs in the physical world but were considered by the PS-ESTs in their posts. These interactions were considered person-structure interactions: The PS-ESTs mentally processed what they observed in the setting at the University (e.g., methods course) and the local elementary school classroom. These interactions featured the elementary-aged student learners and science content or a practice related to teaching science. These interactions were considered important because they represented potential long-term influences on the PS-ESTs perspectives on teaching science.

Student learners and methodology. Observations made by the PS-ESTs illuminated contemplations they had about student learning and methodology within the elementary classroom. The PS-ESTs' reflections generally focused on specific facets of education (e.g. the student, content, classroom practice) as isolated aspects of teaching that operated independently of each other. However, reflections did consist of observations that specifically linked two different entities together. One of the links connected "children" and ways to teach science (e.g. c*onstructivism)* and presumptions of student knowledge about scientific phenomena or valuable skills for learning science or other content areas. In the following post, Stella alludes to how this interaction would unfold in an authentic setting:

> First of all, on a more socially developmental level, discourse & argumentation encourage students to simply talk with others – they work on finding the words to express what they are thinking and learn (if they are taught well) how effective communication works, manners included. By engaging in intelligent conversation with their peers, students learn that everyone thinks in a different way and has different ideas. They can learn to

> think in multiple ways by listening to others' strategies/methods, if they are taught to appreciate diversity of ideas. (Stella, blog post)

Stella's post linked together the use of a specific methodology and student learning, highlighting values that extended beyond content-specific phenomena. In other posts the PS-ESTs alluded to similar ideas, demonstrating that their considerations of the elementary-aged students and methodology were paired. In the following post, Gabriella reveals how the interaction should unfold.

> We have been talking about misconceptions in all of our methods courses and how it is vital for the teacher to discover, in each subject, what the students know so she can better facilitate their learning. In regards to misconceptions in science, I believe that you want your students to not only know what the correct information is, but the correct way to go about finding that information. (Gabriella, blog post)

While Gabriella's post alluded to an idea generated during a methods course discussion, her thoughts illuminated different components of a teaching identity influenced by the student-methodology interaction—the rationale for using specific methodologies. While these observations were generated through carefully scaffolded structures, the PS-ESTs reflections revealed a deeper level of understanding associated with the use of methodology, something expected from a more developed teaching identity.

Summary of Findings in Chapter Four

The analysis of the data in Chapter Four produced three distinct categories of findings associated with the teaching identities of the PS-ESTs. Broadly, they were constructs associated with the: 1) personal agency of the PS-ESTs; 2) structures affiliated with the context that the PS-ESTs “worked in” as students and pre-professionals; and 3) person-person and person-structure interactions.

With PCT, each component (e.g. personal agency) housed unique themes. Within personal agency, agentic findings included beliefs and expectations about the teacher’s agency, prescriptive actions for the benefit of students, and comparisons and dissonance. These findings featured how the PS-ESTs viewed themselves as teachers, what they believed about a teacher’s roles, and how the PS-ESTs managed dissonance, instances in which the contexts contradicted their held beliefs. Besides personal agency and sub-themes associated with it, blogs revealed PS-EST awareness of influential structures associated with contexts relevant to their development as teachers. These structures were manifested in the following themes: 1) situative meaning and social influences. Situative meaning encompassed sub-themes associated with school subculture and the role of science. School-subculture illuminated the influence of methods courses noted for the integration of specific methodologies; field experiences; curriculum, noted more for its limitations than benefits, and perceptions of past classroom experiences that exerted an influence on the PS-ESTs’ past and present beliefs and perceptions. The sub-theme associated with the role of science revealed the influences of content and content roles, specifically iterating why science was both necessary and important for the elementary classroom.

The second theme associated with structures, social influences, exposed another facet of student input as an influence on the PS-ESTs teaching identities. Within this sub-theme, posts indicated that PS-ESTs were influenced by purposes such as preparing students for their future classes or careers, or using the content as a means to satisfy expectations for student engagement. These purposes manifested through the use of hands-on, inquiry-based learning that did not include an explicit emphasis on historical components of scientific knowledge (e.g. facts associated with specific topics, individual biographies)

A final construct within the data was interactions. Within this construct was the theme of developmental dyads that contain two sub-themes: 1) peer interactions and 2) student learner-methodology interactions. With peer interactions, several trends occurred: 1) monologues; 2) question and answers; and 3) acknowledgements of peers. PS-ESTs wrote monologues that were reflective descriptions or perceptions of experiences and not intended for dialogue. These reflections did produce genuine questions, yet with scarcity. Most questions were rhetorical in nature (e.g. *did you ever*…?) and not intended for response as much as a tool for acknowledging a peer or a simple autobiographical *I did this*. Even the required weekly responses amounted to little more than an acknowledgement of peers, statements that consisted of recognition of the individual posting and that indicated the post had been viewed and read. Within the student-content interactions, findings included ideas associated with the elementary-aged student, learning, and methodology. This finding illuminated the benefits of generating student learning by implementing methodologies that responded to students and afforded specific benefits to the students. The PS-ESTs indicated that how students learned by engaging with the methodology influenced their approaches to learning. With this finding, the PS-ESTs demonstrated the importance of having a rationale for specific methods and how method afforded greater opportunities for students to learn.

These findings provide a starting point for understanding more about the development of elementary pre-service teachers, the methods used to teach and develop them, the role of their identities in how they approach practices, and to a lesser degree, the implications of both current s (e.g. methodologies, field experiences) and new (blogging) teacher education practices and the influential contexts that bound them. Chapter Five addresses in depth possible implications.

CHAPTER FIVE

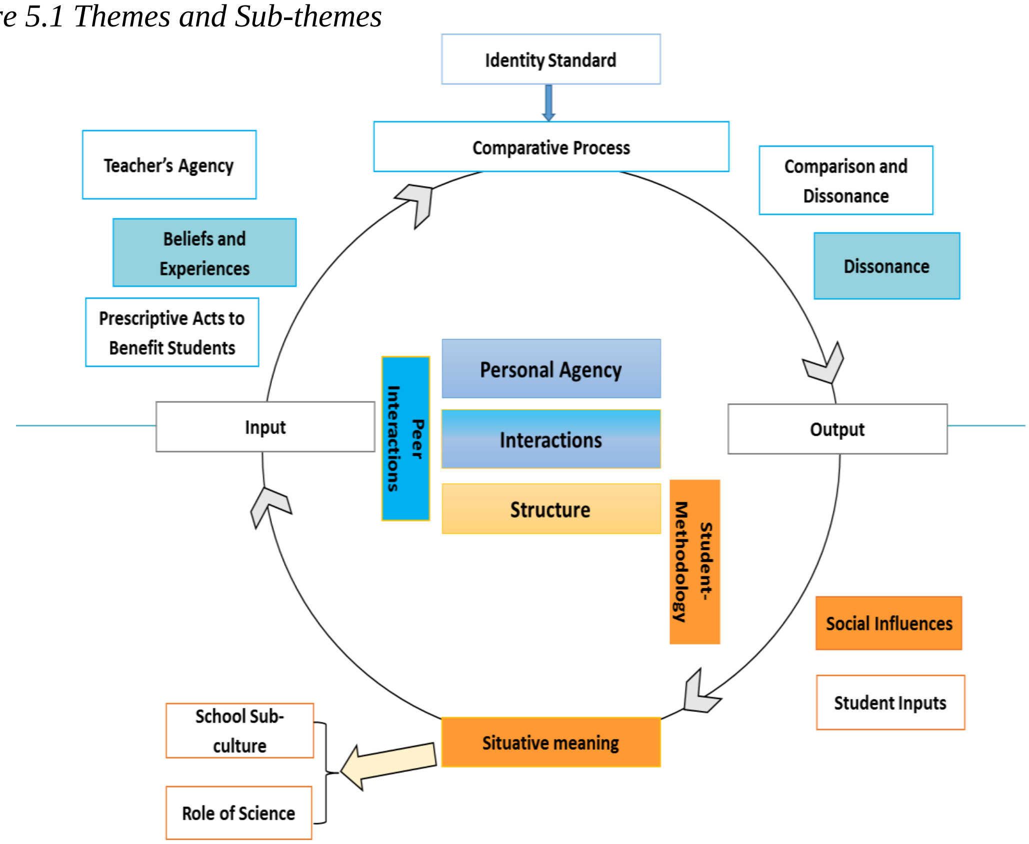
Conclusions and Implications

Challenges associated with science teacher education for pre-service elementary teachers were presented in Chapter One. They included anxiety about self-efficacy and competence with science content, anxiety associated with teaching it to elementary students, and shifts in understanding of science teaching that extended beyond the context of methods courses. While the first two problems are uniquely addressed through coursework, the development of prominent science teaching identities not dependent on scaffolded contexts is elusive. This particular challenge was considered in light of tendencies associated with elementary science education and local elementary school subcultures that minimize science teaching (Baggott La Velle et al., 2004; Meier, 2012; Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012). A proposed solution to the identity-related challenge included efforts to understand what occurs during the PS-ESTs' enrollment in methods coursework (Figure 5.1).

To illuminate possibilities, a research lens specifically focused on identity and revelations generated through social media practices were used to understand PS-ESTs' awareness of their limitations, their teaching identities, their relevant contexts (e.g. methods coursework), and the prominent influences that occurred during their enrollment in an undergraduate methods course. The unique contribution of this effort was how it probed the PS-ESTs' reflections and comments via blogging as they constructed understanding of themselves, teacher roles, classroom practices, and science learning. This research differed from previous research in that it examined interactions and activity situated in a socially mediated environment rather than evaluating the tool (e.g., blogging) being used (e.g. Anderson & Matkins, 2011; Harland & Wondra, 2011).

The reviewed literature produced general ideas associated with the personal beliefs and experiences of PS-ESTs as well as contextual influences associated with teacher education. These contextual influences included the role of science, school sub-cultures, and social influences generated by relevant contextual agents. This review also highlighted influences associated with interactions that were generated through the relevant experiences that occur in teacher education environments. In the following sections, specific attention is given to findings associated with the following: a) PS-ESTs' identity standards; b) structures associated with teacher education; and c) interactions that shaped PS-ESTs' ideas about science teaching in the elementary classroom.

Figure 5.1 Themes and Sub-themes



PS-EST Identity Standards

Data analysis was driven by several questions with the first asking, “What is learned about the identity of PS-ESTs authored through social media?” Findings for this question centered on a construct associated with individual identity, personal agency. This theme was further explicated by sub-themes about the teacher’s role, prescriptive acts that benefit students, and comparisons and dissonance.

For the teacher’s role, the PS-ESTs exhibited awareness of normed behaviors within the classroom, content limitations and strategies, and being a facilitator. Though good intentions were common in posts, strategic planning intended to facilitate student learning through scaffolded lessons were absent from the PS-ESTs’ reflections and conversations. The PS-ESTs acknowledged that student understanding presented challenges; however, besides acknowledgement, no strategic plans for guiding students were explicitly stated. This finding was further evident in the PS-ESTs expressed desire to establish classroom environments for learning.

The teacher’s role was necessarily dichotomous. While acknowledging a place that allowed for the development of important cognitive skills (e.g. critical thinking and problem-solving) the PS-ESTs indicated that science was governed by affective values associated with making the class or the content enjoyable to the students. The PS-EST saw the teacher as having contrarian positions. On one hand, engagement and fun were juxtaposed with content, with one equally as important as the other. The PS-ESTs willingly acknowledged the inherent value of content knowledge by designing lessons for it. On the other hand, affective outcomes were given primacy; the PS-ESTs positioned engagement and fun as the major, most meaningful outcomes. This affective focus was also illustrated by their approach to the classroom. It was to be a warm and accepting place while also serving as a place for the development of content understanding and skills for life. These desires and efforts for the classroom were further cemented by the high valuation the PS-ESTs had for student inputs in their teaching practices.

Student inputs represented a second finding associated with the PS-ESTs because they determined what prescriptive acts the PS-EST would utilize in the classroom. Though they acknowledged the teacher's role as associated with science, the PS-ESTs also indicated that the facilitation of student learning was important. Facilitation was not helping students acquire knowledge by orienting them through careful scaffolding; it was creating an environment for student-driven activity and outcomes that would develop the students. Teachers were not to impose ideas on students and confront their prior understandings, but through license to explore, insure that science learning occurred. While this intent was driven by the right ideals, this tendency to approach science in such a manner left addressing misconceptions, which the PS-ESTs acknowledged and attributed to students' prior knowledge, subject to the student's activity and willingness to embrace proper conceptions. Two major revelations were that students drove learning and that PS-ESTs lacked explicit strategies to address acknowledged challenges associated with student conceptions.

The PS-ESTs noted that students had prior knowledge of scientific phenomena and that this knowledge produced inaccurate conceptions of scientific phenomena. They also wanted students to contribute to classroom activity, allowing them to be determinants of activity, which was revealed through a lack of strategic planning associated with desired learning outcomes. The PS-ESTs were very good at speaking in generalities, yet did not explicitly state specific strategies for conducting or preparing classroom activity.

Structures

The second guiding research question asked, "What contextual influences are acknowledged by PS-ESTs" and "How do PS-ESTs process and utilize these influences?" The second construct that materialized through data analysis, structures, illuminated objective influences that shaped the PS-ESTs' practices and thinking. This construct was represented by two themes situative meaning and social influences. Situative meaning included school subcultures and the role of science while social influences were represented by student inputs.

Situative Meaning. Situative meaning was demonstrated by two distinct influences, the university classroom and the role of content. In analyzing the PS-ESTs reflections the most prominent influences included methodologies espoused through the methods course, field experiences that took place in the local elementary school and curriculum utilized in varying capacities within their field experiences or the methods course. While their perceptions of the teacher's role indicated a digression from systemic or scaffolded practices in the lack of a strategy to achieved specific learning outcomes, the methods course strongly influenced the PS-ESTs' consideration of specific methodologies. Not only were the methodologies given prominence, they seemed to influence the PS-ESTs' expectations for learning outcomes; posts specifically addressed desirable outcomes as defined by the PS-ESTs rather than student-driven ones. These expectations did come into contact with the practices associated with local classrooms. While the PS-ESTs sought to implement ideas and methods taught in the academic course, they acknowledged that strong influences from their field experiences made lasting impressions on them. The most prominent were cooperating teachers who utilized various classroom routines and practices. The PS-ESTs expressed a variety of responses, sometimes accepting the practices as is, and in others, taking a critical stance about the practice. The last noted influence was curriculum.

PS-ESTs saw the benefit of curriculum for the completion of goals, including an expressed and genuine desire to prepare students for their futures by using science learning to encourage the development of higher level thinking. However, these ideas of curriculum presented an interesting contrast in their thinking. While they indicated a limited conception of curriculum, published materials, how they utilized it to prepare their students indicated a heavy reliance of the PS-EST upon already established practices or subcultures. Rarely did they make mention of ways to use available resources to help students or espouse strategies that were not already a component of the structures that influenced them.

PS-ESTs' posts often indicated that past experiences were memorable. The challenge was that their biopic reflections also showed that they did not retain much content or conceptual understanding. This finding corresponded with tendencies acknowledged in their perceptions of the teacher's role where a high value was placed on student engagement and fun versus content or conceptual understanding. Ideal experiences highlighted "cool" or "exciting" new experiences with little mention of what specific ideas were being developed through the experience. Though these experiences overrode how the PS-ESTs were encouraged to approach science, their reflections did indicate a critical position. The PS-ESTs noted the lack of science they saw, which in turn generated a determination by the PS-EST to encourage science in their future classrooms.

Though easily integrated, the role of science was considered to have a situative meaning unique from school subcultures that influenced how it was taught. In their posts, the PS-ESTs revealed that science was often excluded or diminished within the elementary school.

Given the importance of science in society at large, this reduced role was not accepted by the PS-ESTs who saw science as beneficial for students, either because of its inherent value, how it could be utilized to develop meaningful skills for students, or how it could prepare them for future academic or career endeavors.

Social Influences. This second sub-theme associated with the structure included specific agents within the context. Elementary-aged students shaped PS-ESTs' choices of methodology, adjustments to practices within contemporary settings, and considerations of future lessons. The PS-ESTs' posts revealed tendencies to focus on methodologies that either allowed room for individual learning preferences or generated possibilities for group-based activity. Whether individualistic or participatory in nature, practices were not valued if they did not appeal to student curiosities and the use of hands-on activity, which once again illuminated the consistent challenge for content-related outcomes. What defined an ideal outcome remained, at best, unclear. What did materialize were the following expectations, efforts that: 1) avoided normed tendencies; 2) encouraged conceptions with the naïve assumption that such encouragement would dominate in the minds of students; 3) prepared students for future endeavors; and 4) developed personally relevant skills. Though good outcomes, the common tendency remained for the PS-ESTs to speak in generalities without speaking of specific strategies or appropriate levels of detail.

Interactions

The third research question asked, "What interactions are occurring?" and "What roles do these interactions play in the development of PS-ESTs?" Answers to this question generated a finding associated with the final construct, interactions. Interactions were represented by the theme, developmental dyads, which was comprised of two unique sub-themes: peer-interactions and student-methodology interactions. Peer-interactions were a unique component of the data because the PS-ESTs blogged among each other, sharing their experiences and ideas with each other. Student-methodology interactions were mental constructions based on PS-EST perceptions of the role of methodology in student learning. That is, the student-methodology interactions did not transpire but were contemplated by the PS-ESTs.

Peer Interactions. Through blogging PS-ESTs were challenged to engage with each other above and beyond normal face-to-face interactions. The desire was for peers to interact and thus influence perceptions of science teaching and aid development of a science teaching identity. What happened were tendencies to publish monologues, very rare instances where PS-ESTs asked the peer group for assistance through a question, and an abundance of moments where the PS-ESTs acknowledged peers through brief statements intended to recognize specific posts.

Monologues resembled brief speeches about teaching or a specific component of experience and based on their syntax were not written to generate conversation among peers. This finding aligned with the results of previous research that noted social media was a means of self-communication through reflection (Killeavy & Moloney, 2010; Lankshear & Knobel, 2006)

Student-methodology interactions. Certain interactions tended to manifest in the PS-ESTs reflections. While some occurred once or twice, one particular type occurred on multiple occasions. This interaction was associated with elementary students and the use of methodologies, and while it was often a contemplation on the part of the PS-EST, it represented an important influence on the PS-ESTs' approaches to teaching. Given the consistent emphasis on the role of students (e.g. being sensitive to their levels of engagement or excitement), this particular type of interaction implied several important findings for teacher education. First, the PS-ESTs wanted to value student participation, yet did not articulate specific approaches to address acknowledged needs, specifically challenges associated with student conceptions of scientific phenomena. While the PS-ESTs appropriately married methodology with content to aid student learning, the lack of explicit approaches to learning and content-related outcomes meant that student conceptions still needed attention. Second, the recognition presented in this particular interaction showed that the PS-ESTs, at least in the academic setting, exhibited more than a superficial understanding of science teaching in the elementary classroom.

Implications

This research reveals components of PST teaching identities and suggests multiple implications for science teacher education. These implications fall within different domains, including the role of PST understandings of science teaching, the phenomena of science in the schools, perceptions of methodology, the role of student feedback, and development through social media. Implications include: 1) utilizing PST understandings of science teaching to generate relevant science teaching; 2) reorienting PSTs to critique past experiences in order to minimize mimicry of them; 3) uniting facilitation denoted by approaches with specific, detailed learning outcomes and developing strategic problem-solving skills by paying attention to details.; and 4) instituting specific strategies to utilize student backgrounds in the design of classroom practices.

Utilizing PS-ESTs Understanding of Science Teaching

Based on the PSTs' beliefs and understandings, classroom expectations are defined by past experiences and the subculture of schools rather than the PSTs' competencies with science or recognition of its inherent value. PSTs do base the utility of scientific knowledge, and its relevance on student engagement. PSTs prefer that learning be fun, engaging, and acceptable to each student. While good, such beliefs are challenged by external variables, such as reasonable and appropriate expectations for elementary grade level students, societal demands for school science to facilitate the development of 21st century skills, and local, regional, and national standards. Those dedicated to teaching science must develop an understanding of science that is distinct from classroom environments. These understandings may be refined by the perceived utility of science and unless that utility is clearly articulated or demonstrated, science teaching at the elementary grade level may continue to be defined primarily by its ability to engage, motivate, and generate fun for students. Teacher education must find a way to embrace and use PST beliefs to encourage the development of science subcultures in local schools. This may start by understanding the origins of PST beliefs. Identifying origins requires a concerted focus on identity and what influences it. Understanding PSTs' teaching identities may generate a platform for dialogue and development that is beneficial for science teaching and learning in twenty-first century elementary schools.

Reorienting PS-ESTs through Critiques of the Past

PSTs accept any past or current educational phenomenon as a valid or truthful practice. While they rely on personal memories of their own early educational experiences to ensure student excitement and curiosity, a distinct possibility exists that PSTs may perpetuate what they experienced rather than encourage student learning and conceptualizations of science based on effective pedagogical practices. Because PSTs emulate what is expected, beliefs defined by past experiences act as filters for contemporary teaching experiences. The PSTs exhibit a willingness to expose students to unique phenomena to encourage engagement with science, but poor former experiences maintain an influence on contemporary practices. These beliefs generate a reorientation of practices based on what was previously known and experienced. And while PSTs admire or esteem past teachers, their comments on contemporary experiences indicate little influence from peers, academic, or professional agents on developing canonical scientific understandings.

PSTs also do not critique the lack of science teaching during observations of local schools; PS-ESTs' posts lauded the use of specific methodologies associated with their coursework, but only when prompted by academic expectations (e.g. field experiences). The implications for PSTs when they start teaching in a local school are two-fold. First, already established individual teachers do not generate the environment experienced in their methods courses in their schools. Unless the PSTs inherently value science, the absence of science in the school, curriculum, or local classes may not be challenged through the introduction of science-based practices in the classroom. Second, though PSTs acknowledge science because it helps student development, little is known about how the PSTs would integrate science in the local classroom if so inclined. To better ensure the development of classrooms and school subcultures that value science, making the value of science prevalent may encourage PSTs to embrace science beyond their undergraduate experiences. In turn, they, as practicing teachers, may produce academic environments that embrace science.

Uniting Facilitation with Explicit Strategies

Socioculturally, PSTs acknowledge that teachers who impose ideas on students are intrusive or disturbing. To combat this, they embrace the use of contemporary educational practices such as constructivism. Though constructivism is extolled, it makes presumptions about students' funds of knowledge, including base levels of content competency, the ability to have civil and knowledgeable conversations, the use of scientific argumentation, and the use of logic to make evidentiary claims. Though the PSTs' intentions are noble, by focusing on students, they speak in undefined generalities that do not produce specific scaffolding or expectations for success.

Constructivist practices, coupled with the PSTs' own limited content knowledge, are unlikely to generate conceptual changes that are an inherent goal of science. Correcting student misconceptions also requires skill in determining what methodologies to use, what information to emphasize, and strategies for classroom behavior. Though PSTs respect that science generates opportunities for student learning, no strategies aimed at conceptual change were articulated in the blogs. The lack of strategy illuminated PST needs for training in pedagogical problem-solving skills. Specific strategies should be designed with consideration of PSTs' beliefs and the sensitivities produced by them (e.g. girls need encouragement, instruction must integrate students' cultures, science must be relevant, etc.). Because courses that address issues with civic responsibility and problematizing educational practices and structures already exist, deliberate efforts aimed at integrating what is learned from these courses to produce problem-solving skills are required. These new courses must have the chief aim of developing problem resolution skills associated with science education.

The Role of Elementary Students

PSTs repeatedly acknowledge elementary students during experiences, yet little is mentioned about the benefits of this feedback. PSTs perceive that elementary students are not driven by career goals or ambitions but their own curiosities, making elementary school an important building block for future endeavors in science. Therefore, content teaching should be defined by understanding of student backgrounds and interests. Teacher education should focus on clear guidelines that define the teacher's role and what makes the students' backgrounds beneficial. Emphasizing the teacher's role may orient PSTs towards effective facilitation and pedagogical practice that uses student backgrounds to improve or design new, more effective lessons. These lessons may rely upon the local classroom teacher who may need curriculum design skills, skill as a mediator between conceptual understandings and students, and an ability to help students successfully navigate their own curiosities.

Recommendations for Science Teacher Preparation

Science teacher education faces major challenges for the preparation of elementary teacher from three different areas. They are 1) self; 2) school subcultures; and 3) students. First, PS-ESTs must overcome their own self-doubt about their content knowledge and self-efficacy with teaching science. Second, besides their own self-doubts, they must learn to overcome challenges present in elementary school subcultures that are heavily influenced by testing traditions that have valued literacy and math while creating tendencies to teach science as an afterthought. Third, PS-ESTs must learn to value science and instruction because their students have funds of knowledge that produce incomplete conceptions of scientific phenomena. In summary, the following are recommendations for teacher education:

1) A course designed to resolve issues associated with conceptual understandings. This course would entail categorization of misconceptions according to cause (cultural, media-related, etc.), addressing how to resolve issues associated with cause through group discussions and implementation of ideas in field experiences, and using initial interventions to better design strategies for other misconceptions.

2) The development of courses associated specifically with culturally based conceptualizations or general misconceptions.

3) Development of curriculum (e.g. textbooks, lessons) designed specifically for elementary education. These texts may introduce content, acknowledge common misconceptions, and articulate strategies designed to effect conceptual change. Instead of being content-only, these resources may include content units, common misconceptions, and strategies for resolution.

4) Development of specific teaching strategies that challenge students to check their own conceptions with ones that are consistent with scientific ways of knowing the world. These practices can be afforded through the use of technology (e.g. Webquests, apps known for their authentic and accurate content). For younger students, this could be a form of group-think or participation involving class discussion about scientific understandings of phenomena.

5) Using social media to generate networks of teachers that are specifically attuned to common misconceptions. Students can interact with students and teachers from other schools to discuss their understandings through social media.

Future Studies and Direction for Research

Using blogs to examine the individual identities, contextual influences, and interactions associated with teacher education in an elementary education cohort has been completed.

However, there is still a great deal to be learned about utilizing identity as an analytic lens in conjunction with social media. What do these findings mean? This research suggests that teacher identities have both unique attributes associated with individual distinctiveness, as well as role-defined commonalities with vary degrees of complexity. When looking specifically at how PST identities unfolded, the data produced findings about the roles of PST understandings of science teaching, beliefs, and experiences in the development of science teacher identities. Much was also learned about the role of social media. Based on current findings, further research could be conducted to develop more in-depth understandings of PST beliefs and understandings of science teaching, the science subcultures of elementary schools, and how social media can be more effectively used.

This project was conducted to observe and learn about PST identities and the findings indicate areas of emphasis including PST perceptions of students' cultures, beliefs about teaching practices, and refining social media practices to encourage collegiality and conversations about learning and science. Examining these findings would generate a dialogue about the role of individual backgrounds, influences on science learning, and the benefits of social media. And because this study took place with teachers from a large university in a suburban, it would be informative to conduct studies in cooperation with universities and colleges from different settings (e.g. rural, urban, and suburban). The affordances of social media would generate a vehicle for communication, and likely produce unique findings about science teaching in general and regional/national approaches that address how to teach science at the elementary grade levels.

This study's findings have indicated another area for further research: the role of peer influences in how innovative technologies supplement teacher education practices. For example, how do teacher education practices during the implementation of social media practices afford opportunities for peers to interact? What additional outcomes for teacher education may occur as a result? How do the characteristics of teacher education courses and their instructional content influence collegial discourses? What might these new types of discourses mean for the science subcultures of academic cohorts? What might these new types of discourses mean for peer development, the local schools, and STEM learning? What types of scaffolds and supports can be created through the use of social media? What can be learned from research that emphasizes identity shaping variables such as beliefs about teachers' roles in relation to social media? These types of questions need to be examined within the context of the academic classroom in order to have a full understanding of the impact of individual identities on the development of elementary science teaching identities. A more comprehensive view of identity is necessary.

Given the limitations of this data set, a research design that differs from the one employed in this study is warranted. With respect to understanding the impact of identity on the development of future teachers, it would be beneficial to generate a study that examines causation, specifically how PSTs perceive the role of science and the impact of this perception on the teaching of elementary-aged student. For example, this study indicated that PSTs acknowledge that science engages students and that science is fun. Studies that examine these utilitarian ideas of engagement in service to the learning of content and in the context of elementary classrooms can be integrated into teacher preparation programs. Elementary PS-ESTs need to see science as having a utility for students that extends beyond engagement and fun. While not necessarily on the same level as literacy, PS-ESTs are likely to value science in a way that can be tapped to encourage science teaching in the elementary school that elevates content understanding. Understanding the utility of science can be used to evoke and develop beliefs that may result in the PS-EST developing a philosophy for and commitment to teaching content-rich science to elementary-age students.

Another potential study could examine the relationship between the various factors that influence PS-ESTs. A study could investigate the correlations between the PSTs' practices in the classroom and the ideas learned during methods coursework. What practices do the PS-ESTs emulate from their teacher education coursework? Why the selection of these practices to implement? Does a correlation exist between what was stated and practiced during the teacher preparation program and what occurs after the PSTs' induction into the profession? Findings could then be used to enhance the experiences of future methods courses.

This study demonstrated that blogging can be used to observe and understand what occurs in science methods course. While this study approached blogging as the vehicle for capturing and examining the complexities of PST identities, the study's findings also have implications for research on blogging. The existent literature showcased the affordances of social media. For example, there are several acknowledged affordances of social media. First, it enables reflections that are narratives about shared academic or historical experiences (Davis, Beyer, Forbes, & Stevens, 2011; Duffy et al., 2010; Hanuscin, 2013). Second, Blogs generate beneficial conversations because they are created by individuals who are operating with specific perceptions about current and future roles (Burke & Stets, 2009). Third, social media has the potential to enhance development and encourage development beyond undergraduate coursework studies (Anderson et al., 2013; Killeavy & Moloney, 2010; Lankshear & Knobel, 2006; Miranda & Damico, 2013; Watters, 2000). In order for these affordances to be maximized, social media use must occur with the use of specific scaffolding (e.g. specific questions, focus on specific components of academic or field experiences). This study's findings indicated that the affordances of blogging were not optimized. Future research could examine the conditions under which the affordances of blogging flourish and conditions in which more can be done. Additionally, future research could investigate learning outcomes associated with blogging and other forms of social media. While future research is needed on identity as an analytic lens and the use of social media in various teacher education contexts, it is evident from this study that research that synthesizes ideas associated with identity and social media can be used to learn about PS-ESTs to improve science education practices for elementary education majors.

APPENDIX 4A: LIST OF LEVEL ONE CODES

Adaptation of Practice_Future	Description of Context_Academic Classroom	Perception of Pedagogical Preparation_Reflections
Adaptation of Practice_Output	Description of Context_LEA_Reflections	Perception of Pedagogy_Reflections
Adaptation of Practice_Simultaneous	Description of Methodology_Reflection	Perception of Practice_Perceptual Input
Anticipation of Future Practice_Reflection	Developing Belief_Practice-Oriented Belief	Perception of Practice_Reflection
Application of Expert Voice_Output	Evaluation of Practice_Output	Perception of Self as Learner_Reflections
Connection to Experience_Identity Standard	Evaluation thru Personal Experience_Output	Perception of Self as Teacher_Reflection
Contemporary Evaluation_Output	Evaluation_Comparison Process	Perception of Student learner or learners_Reflection
Contemporary Neutral_Experience	Evaluativist_Epistemology	Perception of Student Learners and Content_Reflections
Contemporary Positive_Experience	Expert Reflection/Input_Perceptual Input	Perceptions from Experience_Perceptual Input
Content_Belief	Future Plans_Output	Positive Assessment
Contextual Agent_Admin_Perceptual Input	Grade level Evaluation_Comparison Process	Positive Belief
Contextual Agent_CT_Perceptual Input	Historical Negative_Experience	Positive Reflection_Reflections
Contextual Agent_Peer_Perceptual Input	Historical Positive_Experience	Prior Knowledge_Identity Standard
Contextual Agent_Student_Perceptual Input	Historical_Neutral_Experience	PST_Take Away_Reflections
Conversational Question_Peer-Response	Historical_Reflection	Refrabrication_Output
Critical Belief	Methodological_Continuation_Output	Reinforcement_Output
Critical Belief_Classroom Environment	Methodology_Output	Response to Peer Comment_Peer Response
Critical Belief_Content	Methodology_Perceptual Input	Response to Peer Question_Peer-Response

Critical Belief_Curriculum Use	Nature of Science_Epistemology	Role of Content_Identity Standard
Critical Belief_LEA Practice	Negative Assessment	Role of Practice_Identity Standard
Critical Belief_Methodology	Negative Belief	Role_Identity Standard
Critical Belief_Peer	Neutral Belief	Self-meaning/Self-reflection_Perceptual Input
Critical Belief_Peer_Practice-oriented Belief	Neutral Reflection_Reflections	Student Take-away_Reflections
Critical Belief_Personal Practice	Own to Other_Comparison Process	Understanding of Methodology/Terminology_Identity Standard
Critical Belief_Role of Assessment	Peer Reflection_Reflections	
Critical Belief_Role of Content	Peer-induced Development_Identity Standard	
Critical Belief_Role of Experience	Perception of Academic Content_Reflection	
Critical Belief_Role of Pedagogy_Practice-oriented Belief	Perception of Assessment_Reflections	
Critical Belief_Role of Published Curriculum	Perception of Classroom Practice_Historical_Reflection	
Critical Belief_Self_Practice-oriented Belief	Perception of Classroom Practice_Reflection	
Critical Belief_Student Practice	Perception of Content_Reflections	
Critical Belief_Teacher Roles	Perception of Curriculum or Published Curriculum_Reflections	
Current to Past_Comparison Process	Perception of Experience_Reflections	
Defining Science_Epistemology	Perception of LEA_Reflection	
Description of Academic Content_Reflections	Perception of Learners_Reflection	
Description of Classroom Practice_Reflection	Perception of Methodology_Reflections	
Description of Content_Reflections	Perception of Parent Role_Reflection	

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