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## **ABSTRACT**

The purpose of this two-phase, sequential explanatory mixed-methods study was to understand and explain the variation seen in secondary science teachers' enactment of reform-based instructional practices. Utilizing teacher socialization theory, this mixed-methods analysis was conducted to determine the relative influence of secondary science teachers' characteristics, backgrounds and experiences across their teacher development to explain the range of teaching practices exhibited by graduates from three reform-oriented teacher preparation programs. Data for this study were obtained from the Investigating the Meaningfulness of Preservice Programs Across the Continuum of Teaching (IMPPACT) Project, a multi-university, longitudinal study funded by NSF.

In the first quantitative phase of the study, data for the sample (N=120) were collected from three surveys from the IMPPACT Project database. Hierarchical multiple regression analysis was used to examine the separate as well as the combined influence of factors such as teachers' personal and professional background characteristics, beliefs about reform-based science teaching, feelings of preparedness to teach science, school context, school culture and climate of professional learning, and influences of the policy environment on the teachers' use of reform-based instructional practices. Findings indicate three blocks of variables, professional background, beliefs/efficacy, and local school context added significant contribution to explaining nearly 38% of the variation in secondary science teachers' use of reform-based instructional practices. The five variables that significantly contributed to explaining variation in teachers' use of reform-based instructional practices in the full model were, university of teacher preparation, sense of preparation for teaching science, the quality of professional development, science content focused professional, and the perceived level of professional autonomy.

Using the results from phase one, the second qualitative phase selected six case study teachers based on their levels of reform-based teaching practices to highlight teachers across the range of practices from low, average, to high levels of implementation. Using multiple interview sources, phase two helped to further explain the variation in levels of reform-based practices. Themes related to teachers' backgrounds, local contexts, and state policy environments were developed as they related to teachers' socialization experiences across these contexts. The results of the qualitative analysis identified the following factors differentiating teachers who enacted reform-based instructional practices from those who did not: 1) extensive science research experiences prior to their preservice teacher preparation; 2) the structure and quality of their field placements; 3) developing and valuing a research-based understanding of teaching and learning as a result of their preservice teacher preparation experiences; 4) the professional culture of their school context where there was support for a high degree of professional autonomy and receiving support from "educational companions" with a specific focus on teacher pedagogy to support student learning; and 5) a greater sense of agency to navigate their districts' interpretation and implementation of state policies. Implications for key stakeholders as well as directions for future research are discussed.

REFORM-BASED SCIENCE TEACHING: A MIXED-METHODS APPROACH TO  
EXPLAINING VARIATION IN SECONDARY SCIENCE TEACHER PRACTICE

By

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Dissertation

Submitted in partial fulfillment of the requirements for the degree of  
Doctor of Philosophy in Science Education

Syracuse University

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## **CHAPTER ONE: INTRODUCTION**

National concerns about the quality of science education continue to rise as the United States falls behind other countries in international comparisons of science and mathematics performance. Results from the 2011 Trends in International Mathematics and Science Study (TIMSS) show that students from the United States rank seventh in the world at the fourth grade level and tenth in the world at the eighth grade level in their science achievement (Martin, Mullis, Foy, & Stanco, 2012). Additionally, the most recent results from the Program for International Student Assessment (PISA) show average scores in science literacy for 15 year olds in the United States are lower than 22 other countries (Kelly, Xie, Nord, Jenkins, Chan, & Kastberg, 2013). Findings from both of these longitudinal studies echo results of the previous TIMSS and PISA studies, which indicate US students have made little progress in closing the gap between the leading nations. This lagging performance heightens concerns about the United States' ability to remain competitive in the global marketplace and to deal with scientific and technological challenges of the 21<sup>st</sup> century.

The President's Council of Advisors on Science and Technology (PCAST, 2010) report on the future of Science, Technology, Engineering, and Mathematics (STEM) education argues "STEM education will determine whether the United States will remain a leader among nations...the country's need for a world-leading STEM workforce and scientifically, mathematically, and technologically literate populace has become even greater and will continue to grow – particularly as other nations continue to make rapid advances in science and technology" (p.1). These assertions regarding the significant role that science education plays in increasing scientific literacy, and in shaping the success of the nation have permeated the discourse on science education for the last two decades (National Research Council [NRC],

1996; Rutherford & Ahlgren, 1991). Though national attention to this issue has spurred reform efforts increasing standards and accountability, there has been relatively little improvement in the quality of science education (NRC, 2007). Science education has become a “perennial issue of national concern” and the need to understand how to improve it is stronger than ever (NRC, 2007, p. 12).

Concerns regarding science education have spurred a focus on teachers, drawing attention to what teachers can do to increase student achievement. Teachers have been identified as the “linchpin” and the “single most important factor” in changing the K-12 science education system (NRC, 2012, p. 255; PCAST, 2010, p. 63). As such, teachers have been scrutinized as the focal point of change in the education system as both the source of, and solution for, students lagging science achievement. The National Commission on Teaching and America’s Future (NCTAF) 1996 report, *What Matters Most: Teaching for America’s Future*, concluded, “what teachers know and do is the most important influence on what students learn. Competent and caring teaching should be a student right” (p. 15). Recent studies have positively linked teacher effectiveness with student achievement, confirming the importance of teacher quality in U.S. education (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008; Clotfelter, Ladd, & Vigdor, 2007; Hanushek, 2003).

While the impact that effective teachers have on student achievement is not a matter of dispute, understanding what effective or quality teaching looks like is more of a contentious debate. Boyd et al. (2008) state, “while there is increasing consensus that more effective teachers produce dramatically greater student achievement than less effective teachers, much less consensus exists on the attributes of teachers responsible for these differences” (p. 4). Federal policies such as No Child Left Behind (NCLB) sought to increase the number of effective

teachers through policy mandates for all students to be taught by “highly qualified” teachers as well as created a system of accountability for teachers and schools to improve student learning (Robelen, 2002). According to the NCLB policy, teachers are determined to be highly qualified if they: (a) have a bachelor’s degree, (b) possess full certification, and (c) have demonstrated content knowledge in core subjects taught (Smith, Desimone, & Ueno, 2005). Yet eight years after the NCLB act was signed into law, the PCAST 2010 reported there were still not enough effective STEM teachers in our Nation’s classrooms.

Evaluations of policy mandates for ensuring highly qualified teachers and the push for greater accountability of student learning have focused primarily on measuring teacher quality on a single outcome measure; student achievement. However, research has neglected the study of effective instruction as the “implicit mediator” between teacher quality and student achievement (Smith, Desimone, & Ueno, 2005, p. 76). Scholars argue that studying the quality of classroom instruction is equally as important to consider in any effort to improve student achievement (Blank, Porter, & Smithson, 2001; Tobias & Baffert, 2010). Brooks and Brooks (1999) assert, “educational reform must start with *how* students learn and *how* teachers teach, not with legislated outcomes” (p. 4). This study adds to this research base by investigating factors that influence secondary science teachers’ use of effective teaching practices over the course of their teacher development. In order to analyze and evaluate the quality of science classroom instruction, it is first necessary to understand how students learn science best and how this informs best practices for science teacher pedagogy.

## **Reforms for Science Learning and Teaching**

Science education standards-based reforms of the last two decades have evolved from research on how students learn science best. The philosophical underpinning of a reformed view of science learning is based on the constructivist theory of learning. Richardson (2003) defines constructivism as a “theory of learning or meaning making, that individuals create their own new understandings on the basis of and interaction between what they already know and believe and ideas and knowledge with which they come into contact” (pp. 1623-1624 ). Though theorists hold many differing views of constructivism as a learning theory, two main distinctions are based on the emphasis placed on “individual cognitive processes or the social co-construction of knowledge” (Windschitl, 2002, p. 136). Influenced by the work of Piaget, a more cognitive notion of constructivism asserts individual learners actively construct meaning based on personal experience and the way in which their previously held understandings interact with new situations to bring about a need for restructuring their understanding (Windschitl, 2002; Philips, 1995; Richardson, 2003). Influenced by Vygotsky’s work, a conception of social constructivism “views knowledge as a cultural product” focusing on the role of social contexts within schools and collaborative learning activities to foster understanding (Windschitl, 2002, p. 141). Those these two conceptions of learning appear to position the role of the individual against the role of the social context, much of what is articulated in a reformed view of learning can be seen as a “hybrid” of the two perspectives, combining “aspects of both the cognitive and the social traditions” (Windschitl, 2002, p. 137).

Based on this theory of learning, these reforms have called for a shift in the way in which students learn science; a shift to a more inquiry based approach to developing scientific knowledge (NRC, 1996). This reformed view of science learning is one in which students learn



by “being actively engaged in the practices of science including conducting investigations; sharing ideas with peers; [using] specialized ways of talking and writing about science; and development of representations of phenomena” (NRC, 2007, p. 251).

The Benchmarks for Science Literacy (American Association for the Advancement for Science (AAAS, 1993) and the National Science Education Standards (NSES, NRC, 1996) were developed as frameworks to help guide and shape the reform of science curriculum. These frameworks were critical in providing guidance for narrowing the scope of what is taught in science as well as promoting a more active role for students in the science classroom (NRC, 2007). Based on the core components of these preceding frameworks, the Next Generation Science Standards (NGSS) put forth in 2013 further clarify the knowledge and practices essential for science learning. The NRC’s (2012) new Framework for K-12 Science Education, a precursor to the Next Generation Science Standards, details the “practices” students should be engaged in to “better specify what is meant by inquiry in science and the range of cognitive, social, and physical practices that it requires” (p. 30). This new framework highlights the importance of integrating scientific knowledge with scientific practices arguing “students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves” (NRC, 2012, p. 30). Based on this framework, the NGSS seeks to more clearly define what this integration of knowledge and practice means for science learning and to articulate the core scientific ideas to be included in K-12 science education (NGSS Lead States, 2013).

In addition to our changing understanding of how students learn science best has been a call for the reform of science teaching. This constructivist based view of learning science, one which involves the integration of knowledge and practice, has helped to shape a constructivist

based approach to science teaching. Richardson (2003) identified the following characteristics of a constructivist approach to teaching:

1. Attention to the individual and respect for students' background and developing understandings of and beliefs about elements of the domain (also described as student centered)
2. Facilitation of group dialogue that explores an element of the domain with the purpose of leading to the creation and shared understanding of a topic
3. Planned and often unplanned introduction of formal domain knowledge into the conversation through direct instruction, reference to text, exploration of a web site, or some other means
4. Provision of opportunities for students to determine, challenge, change or add to existing beliefs and understandings through engagement in tasks that are structured for this purpose
5. Development of students' metawareness of their own understandings and learning processes (p. 1626)

These characteristics of constructivist pedagogy represent a shift away from the standard instructional approach, often referred to as traditional, or teacher-centered in which the activity of the classroom is focused on, and guided by, what the teacher does. A constructivist approach, often referred to as student-centered, focuses first on the learner and draws the student into the activity of the classroom. Feiman-Nemser (2001) described reform-based models of teaching as encouraging "teachers to do more listening as they elicit student thinking and assess their

understanding and for students to do more asking and explaining as they investigate authentic problems and share their solutions” (p. 1015). Thus, a reform-based model of science teaching, rooted in the characteristics of constructivist pedagogy, is “fundamentally different from traditional classroom practices” (Southerland, Sowell, & Enderle, 2011, p. 438).

The NSES (NRC, 1996) outlined necessary reforms for science teaching to best support learning. These science teaching standards emphasize a shift away from the traditional teacher-centered approach to teachers and students working together as active learners (see figure 1). The standards envisioned the science teacher as a facilitator creating an environment for active learners involved in either guided or self led investigations of real world phenomena, fostering collaboration among students, and integrating the nature of science across the science curriculum. The vision in these standards also suggests teachers find a balance between incorporating student interests and goals with their own plan for content to be taught. More recently, the NRC’s 2007 report *Taking Science to School: Learning and Teaching Science in Grades K-8* argues, “quality instruction should promote a sense of science as a meaningful process of building and improving knowledge and understanding” (NRC, 2007, p. 343). This report highlights quality reform-based science instruction to include:

1. All major aspects of inquiry, including managing the process, making sense of data, and discussion and reflection on the results, may require guidance.
2. Instruction needs to build incrementally toward more sophisticated understanding and practices. To advance students’ conceptual understanding, prior knowledge and questions should be evoked and linked to experiences with experiments, data, and phenomena. Practices can be supported with explicit structures or by providing criteria that help guide the work.

3. Discourse and classroom discussion are key to supporting learning in science. Students need encouragement and guidance to articulate their ideas and recognize that explanation rather than facts is the goal of the scientific enterprise.

4. Ongoing assessment is an integral part of instruction that can foster student learning when appropriately designed and used regularly. (p. 251)

*Figure 1. Changing Emphasis of Science Teaching*

<b>Less Emphasis On</b>	<b>More Emphasis On</b>
Treating all students alike and responding to the group as a whole	Understanding and responding to individual student's interests, strengths, experiences, and needs
Rigidly following curriculum	Selecting and adapting curriculum
Focusing on student acquisition of information	Focusing on student understanding and use of scientific knowledge, ideas, and inquiry processes
Presenting scientific knowledge through lecture, text, and demonstration	Guiding students in active and extended scientific inquiry
Asking for recitation of acquired knowledge	Providing opportunities for scientific discussion and debate among students
Testing students for factual information at the end of the unit or chapter	Continuously assessing student understanding
Maintaining responsibility and authority	Sharing responsibility for learning with students
Supporting competition	Supporting a classroom community with cooperation, shared responsibility, and respect
Working alone	Working with other teachers to enhance the science program

Note. From National Science Education Standards (NRC, 2006, p. 52)

These components of effective science instruction echo those of the NSES a decade earlier and help to define reform-based science teaching. The reform-based science instructional approaches are a “dramatic departure from the typical approach, revealing that science instruction can be much more powerful and can take on new forms that enable students to participate in science as practice and to master core conceptual domains more fully” (NRC, 2007, p. 254). Achieving success in standards-based reform of science education to enhance the scientific literacy of students is not met without attention to the effectiveness of science teachers in implementing these reformed instructional practices. Swanson and Stevenson (2002) argue “instructional practices represent a critical yet intermediate stage in the process of implementing standards-based reform” (p. 19). Yet even after decades of reform and research detailing how students learn science and the necessary instructional practices to achieve “this image of science as practice”, much of this reform-based pedagogy evades the nation’s classrooms (NRC, 2007, p. 255). More research is needed to understand what influences the instructional practices of science teachers, and how these influences relate to the use of effective teaching practices called for in standards-based reforms.

### **Statement of the Problem**

Despite the research on best practices for reforming teaching and learning science, reform-based instructional practices are largely absent from the majority of U.S. science classrooms (Capps & Crawford, 2013; Luehmann, 2007; Windschitl, 2002). In fact, Woodbury and Gess-Newsome (2002) suggest that being in school today is “fundamentally the same as it was 100 years ago” (p. 764). Instructional practices that reflect a more traditional teacher-centered, knowledge transmission model of science education still dominate the school science classroom. The NRC (2007) argues this typical approach to science instruction conveys “a

passive and narrow view of science learning or an activity-oriented approach devoid of question-probing and only loosely related to conceptual learning goals” (p. 254). From an analysis of 350 mathematics and science lessons across the country, Weiss and Pasley (2004) concluded U.S. schools are falling short of providing high quality science instruction for all students. What has transpired in the last two decades of standards-based reform is a “paradox of change without difference,” an enormous effort to reform science education resulting in little change in classroom practice (Woodbury & Gess-Newsome, 2002).

The PCAST 2010 report claims that schools lack teachers who know how to teach science effectively, and who know the subject content well enough to inspire students to achieve success in science. Yet even teachers who are prepared to teach in reform-oriented science teacher preparation programs struggle to implement reform-based instructional practices (Davis, Petish, & Smithey, 2006; Luehmann, 2007; McGinnis, Parker, & Graber, 2004; Simmons et al., 1999, Tillotson & Young, 2013). “To teach inquiry-oriented science as recommended by current reforms in science education, a teacher must also hold strong understandings of and abilities with regard to science inquiry” (Davis et al., 2006, p. 615). For many, reform-oriented teacher preparation programs promote an approach to teaching that requires teachers to take on new roles for themselves as a teacher. Because so few teachers have experienced this kind of teaching themselves as a student, they are often lost in translation when trying to take on these new roles (Korthagen, 2004).

The theory of teacher socialization is a useful lens to examine what practices teachers take up in the process of learning to teach science, and to explain variations in the levels of reform-based practices enacted in classrooms. Teacher socialization is described as the “process whereby the individual becomes a participating member of the society of teachers” (Zeichner &

Gore, 1990, p. 329). Factors such as teachers' personal histories, professional preparation, the school context, and state policy environment all interact during this process of socialization (Achinstein, Ogawa, & Speiglmán, 2004). Learning about and taking on the role of science teacher is part of the teacher socialization process. As teachers engage in learning what it means to be an effective reform-based science teacher across multiple teaching contexts, they find themselves either passively or actively adjusting their role as teacher to the culture of the profession (Zeichner & Gore, 1990).

Many scholars have attended to this problem of “change without difference,” investigating how various aspects of teachers' backgrounds, preparation, school contexts, and policy environments influence the instructional practices teachers use. This research base reveals a variety of factors that relate to science teacher effectiveness, and factors that may contribute to teachers' use of reform-based instructional practices. Teachers' attitudes and beliefs about reformed-science instruction are influential in teachers' enactment (Richardson, 1996; Roehrig & Kruse, 2005; Savasci & Berlin, 2012), or intent to enact, this type of instruction (Haney, Czerniak, & Lumpe, 1996). Other studies have revealed that teacher participation in content-oriented professional development is associated with an increased use of reform-based instructional practices (Garet, Porter, Desimone, Birman, & Yoon, 2001; Smith, Desimone, & Ueno, 2005; Smith, Desimone, Zeidner, Dunn, Bhatt, & Rummyantseva, 2007). Teachers' school context, school culture, or perception of school culture, has been referred to as the “primary limiting factor” influencing teachers' use of reform-based instructional practices (McGinnis, Parker, & Graber, 2004, p. 743). Previous research has produced evidence that some teacher preparation programs have a positive influence on teacher beliefs about, and feelings of preparedness, to implement reform-based teaching practices, (Simmons et al., 1999; Swars, Hart,

Smith, Smith, & Tolar, 2007; Tatto, 1998; Tillotson & Young, 2013) as well as increased use of reform-based practices (Brouwer & Korthagen, 2005; Huffman, Thomas, & Lawrenz, 2008; Tillotson & Young, 2013). While there is evidence that some teachers enact reform-based instructional practices, it is not yet clearly understood what factors contribute most to these teachers' use of these instructional practices.

Although there is an abundance of research that attends to the relationship between individual factors and instructional practices of science teachers, few studies have taken a systemic look across these factors to understand how various aspects of the teacher socialization process explain the range of practices teachers use in the secondary science classroom. Understanding the process of learning to teach in a manner that reflects current science education reforms is a multifaceted issue happening across multiple contexts. To develop a comprehensive understanding of how reform efforts are manifested in teachers' practice, research should include multiple variables including the contextual factors of structure and cultures of schools, teachers' personal contextual factors, and teachers' perceptions of reform ideas (Woodbury & Gess-Newsome, 2002). In order for policy and reform efforts to support teachers in the use of novel instructional practices, it is important to understand more specifically why some graduates of reform-based teacher preparation implement reform-based teaching practices in secondary science classrooms while others do not.

### **Purpose of the Study**

The purpose of this two-phase, sequential explanatory mixed-methods study is to determine the relative influence of secondary science teachers' characteristics, backgrounds, and experiences across their teacher development to explain the range of teaching practices exhibited by graduates from three reform-oriented teacher preparation programs. This study utilizes an



extant data set collected from The IMPPACT Project (Investigating the Meaningfulness of Preservice Programs Across the Continuum of Teaching in Science Education, NSF TPC Grant # 0455819); a multi-university, five-year research study designed to examine the beliefs and practices of secondary science teachers across various stages of the learning to teach continuum. The IMPPACT study used longitudinal design involving a collection of quantitative and qualitative data to better understand the overall impact of science teacher preparation programs. The IMPPACT project investigators randomly sampled cohorts of pre-service and in-service science teachers at each university across key stages of the teacher continuum (40 teachers per university x 3 universities = minimum of 120 total science teachers in the overall study) and tracked them for a period of four years. A smaller sub-sample of teachers at each site (10/site) was selected for in-depth analysis and more extensive data collection. Data for this current study is drawn from the multiple repeated surveys of the broader IMPPACT sample population as well as from the numerous interviews conducted with the smaller sub-sample of “in-depth” teachers throughout the course of the project.

This current study utilizes teacher socialization as a guiding framework in the identification of variables and analysis of data. Various factors important to the socialization of teachers, and the resulting instructional practices they implement included in this investigation are: teachers’ personal and professional background characteristics, beliefs about reform-based science teaching, feelings of preparedness to teach science, school context, school culture and climate of professional learning, and influences of the policy environment. In the first phase, hierarchical multiple regression analysis is used to examine the separate as well as the combined influence of these factors on the teachers’ use of reform-based teaching practices. Information from this first phase was explored further in a subsequent qualitative phase. Using the results

from phase one, six teachers were selected based on their levels of reform-based teaching practices to highlight teachers across the range of practices from low, average, to high levels of implementation. Multi-case study methods were used to further the analysis by providing an in-depth analysis of factors related to these six teachers' use of reform-based teaching practice. The qualitative research phase helped to explain the variations in levels of practice exhibited by secondary science teachers.

The study addresses the following research questions:

Phase 1:

- 1) How much variation in secondary science teachers' use of reform-based instructional practices is accounted for by a set of personal background variables (gender, race, and level of science content knowledge), a set of professional background variables (teacher preparation program, type of certification degree, and years of experience teaching), a set of efficacy/beliefs variables (sense of preparedness and beliefs about reform-based science teaching), a set of school contextual variables (school context, school climate/culture, and professional development opportunities), and a policy related variable (policy related instructional influences)?
- 2) Do school contextual variables and policy influences explain additional variation in teacher practices after accounting for the variation in practice due to personal and professional background variables and efficacy/beliefs variables?

## Phase 2:

1) How do the factors identified in the model related to teacher backgrounds, local school context, and state policy environment contribute to explaining the differences in levels of reform-based science teaching exhibited by graduates from three reform-oriented teacher preparation programs?

### **Significance of the Study**

Previous analyses of IMPPACT study data have provided evidence that a small number of teacher preparation program graduates go on to implement reform-based instructional practices in their classroom (Tillotson & Young, 2013). Given the overall low incidence of reform-based science teaching practices in secondary science classrooms, it is important to understand why some graduates of science teacher preparation programs engage in these practices while many do not. Recent research has attended to a more systematic view of explaining the variation of practice exhibited by secondary teachers prepared in reform-oriented teacher preparation programs. Much of this research has been qualitative focusing on smaller in-depth analysis of teachers to help explain this differential implementation of reform-based instruction (Achinstein, Ogawa, & Speiglmann, 2004; Crawford, 2007; Thompson, Windschitl, & Braaten, 2010). Scholars have also addressed this problem using quantitative studies seeking to assess the relative influences of various policy mandates to science teacher practice (Smith et al., 2007) as well as relationships between beliefs and teacher preparation to science teacher practice (Tillotson & Young, 2013). However in the research base, there are few mixed-methods studies that examine how various aspects of teacher socialization influence the practice of secondary science teachers. Brouwer and Korthagen (2005) conducted a longitudinal mixed-methods study of the relative influence of teacher preparation and school context on teacher practice, finding

that pre-service training can counterbalance the impact of occupational socialization of school context. However this study did not specifically focus on science teachers and the sample did not contain U.S. teachers. This current study adds to the research base regarding the relative strengths of various socializing factors on teachers practice. The analysis of quantitative data from a large sample of graduates from three universities of varying experience levels allows for greater generalizability of the findings as opposed to the majority of research on teacher practice that is primarily qualitative in nature and focused on small samples of teachers, or graduates, from a single university (Windschitl, 2005).

This study also adds to the reported gaps in the research base on science teacher practice. Thinking of teacher education as a “system of activity” research studies must include analysis of teacher development across multiple contexts as well as demonstrate causal or correlational links (Windschitl, 2005). A deeper understanding of teachers’ enculturation into the science education community as well as a better understanding of how the context and settings affect beginning teachers is needed (Luft, 2007) to better understand conditions that support or constrain teachers to use what they have learned in their preparation (NRC, 2010). The design of this study addresses these research gaps, adding to the knowledge-base regarding specific experiences and socialization forces that influence the enactment of reform-based teaching practices by secondary science teachers.

This research also has the potential to influence policy regarding teacher learning (both pre-service and in-service). Fieman-Nemser (2001) notes, “policymakers and educators are coming to see that what students learn is directly related to what and how teachers teach; and what and how teachers teach depends on the knowledge, skills and commitments they bring to their teaching and the opportunities they have to continue learning in and from their practice” (p.

1013). It is ever more important to understand what factors contribute to effective science teaching as the Federal Government has set a goal for the preparation and induction of 100,000 new SETM teachers over the next decade (PCAST, 2010). With mounting concerns about the state of science education and the role teachers play in improving the quality of science education, this research contributes to furthering our understanding of how to best support new teachers as they are socialized into the teaching profession across the various contexts of learning to teach.

## **CHAPTER TWO: REVIEW OF THE LITERATURE**

The goal of this study was to explain the variation in secondary science teaching practices exhibited by graduates of three reform-based science teacher preparation programs, and to best understand what influences some teachers' to implement reform-based teaching practices. To frame this research, it is necessary to take a broad look across the literature at the various interacting components that influence teaching. The following review of the literature will first orient the study within a theoretical framework that guided the design and analysis. The chapter continues with a review of the literature embedded within the major spheres of influence on teaching outlined in the framework.

### **Theoretical Framework**

The theoretical frame of teacher socialization primarily guided this research, which examined secondary science teacher practice. The use of this perspective allowed for a systematic examination of the various components of teacher development, and how the processes of learning to teach and the environments in which this learning takes place interact to shape the types of instructional practices teachers implement. From this "theoretical vantage point" this study viewed socialization across the learning to teach continuum – examining teachers' personal backgrounds, teacher preparation, in-service school culture and learning, and state policy environments that help to shape teachers' pedagogical style (Anderson & Helms, 2001, p. 4).

Sociologist Robert Merton (1957) defined socialization as "the process by which people selectively acquire the values and attitudes, the interests, skills and knowledge – in short the culture – current in groups to which they are, or seek to become, a member" (as cited in Lacey, 1977, p. 13). Teacher socialization in particular then, is "a field of scholarship which seeks to

understand the process whereby the individual becomes a participating member of the society of teachers” (Zeichner & Gore, 1990, p. 329). Within the research of teacher socialization there are three main traditions, the functionalist model, the interpretive model, and the critical model, each with its own theoretical orientation.

The functionalist model of socialization is the oldest approach to teacher socialization and is a viewpoint that tends to be positivist in nature. As Lacey (1977) points out it “stresses the notion that socialization fits the individual to society” (p. 19). In general a functionalist model “is characterized by a concern for providing explanations of the status quo, social order, consensus, social integration, solidarity, need satisfaction, and actuality” (Zeichner & Gore, 1990, p. 330). A central thesis to this tradition is a view that teachers lack agency – teachers are socialized into the role of teaching with no choice or effect on the role of teaching itself. Merton’s definition of socialization positions itself within the functionalist model. Lacey’s (1977) critique of Merton’s definition is that “there is a high degree of determinism in this view of society and the individual’s relationship to it. The individual does not have much choice, he joins or does not join the group in question” (p.19).

An interpretive model of socialization grew out of such critiques of the functionalist approach. The interpretive tradition is more concerned with the subjective experience of teachers acknowledging socialization “as a more complex and problematic process” than when viewed through a functionalist lens (Zeichner & Gore, 1990, p.330). While a functionalist approach may seek to explain an observable external reality that impacts teachers, an interpretive approach seeks to understand the process of learning to teach from the perspective of a teacher who has agency and is involved in affecting this process (Zeichner & Gore, 1990). Though these two perspectives have inherent differences, Zeichner and Gore point to the similarity of these

two models in that “Both view socialization as an overarching process whereby the individual engages in role learning which results in the situational adjustment (passive or active) of the individual to the culture of the profession” (p. 331).

The third model of socialization, a critical model, differs from the previous two in that the underlying assumption is a challenge of the status quo. Zeichner and Gore (1990) describe the basis of this approach as having a primary concern for “social transformation aimed at increasing justice, equality, freedom, and human dignity. Reality is viewed as socially created and sustained” (p. 331). Lacey (1977) argues socialization is a lot less straightforward than a dominant perspective might reveal. It is, therefore, important to understand and consider the conflict that is produced within and between groups as it relates to gender, class, ethnicity, religion, and political differences.

This study aligned with an interpretive perspective on teacher socialization to guide the design and data analysis. Though the use of a quantitative model in an attempt to understand teachers’ practices may resonate with a functionalist approach in the minds of some, the use of data as reported from teachers via survey as the base of quantitative data analysis brings in the teachers’ perspective on what shapes their practice. The mixed-methods design itself was also an attempt to take a more interpretive stance. Therefore this study includes detailed interview data that incorporates the experiences of the teachers from their perspectives in order to aid in understanding their developing pedagogy.

As individuals go through a process of teacher socialization they become a part of a culture of teaching; developing knowledge, beliefs and attitudes about teaching and learning, and honing skills related to the tasks of the job. While there are many aspects to the socialization of teachers, one such outcome or product of the process of teacher socialization is the eventual



instructional practices a teacher chooses to implement in the classroom. This process of learning about teaching and how to put this into practice is developed along a continuum of experiences in which there are a variety of factors that interact to shape the kinds of instructional practices a teacher will choose to use in the classroom. Teacher socialization from this vantage point allows one to look at these variables together in conjunction with the various settings to attempt to understand how both the teacher as an individual and the institutions along their teacher development work together in the socialization process. Across the different stages of learning to teach there are various factors that influence teacher socialization. The following literature review is organized to discuss these various factors as they relate to three main spheres along the continuum of teacher development that research has identified as influential to the socialization of teachers and their developing instructional practices, (a) teachers' backgrounds, (b) local contexts, and (c) state policy environments (Achinstein, Ogawa, & Speiglman, 2004).

### **Sphere One: Teachers' Backgrounds**

#### **Personal Backgrounds**

This first sphere, which encompasses teachers' personal and professional backgrounds, both directly and indirectly shapes the socialization of teachers which influences their instructional practices (Achinstein, Ogawa, & Speiglman, 2004). These authors contend that personal characteristics of teachers, their cultural, racial, and class backgrounds are influential to their socialization into the teaching profession because these factors work together to form their worldviews. These worldviews in turn affect the kinds of jobs teachers accept, and the ways in which they interact with student populations in their school districts (Achinstein, Ogawa, & Speiglman, 2004).

### **Personal histories**

Teachers' personal backgrounds include their personal histories. These personal histories, including schooling history or any learning experiences prior to formal training in teacher education, have been argued to be highly influential in the socialization of teachers. Lortie (1975) explains the influence of school history on the socialization of teachers as an "apprenticeship of observation". According to Lortie, the socialization of teachers is largely influenced by the countless hours teachers spend in the classroom as students themselves, observing and internalizing instructional models of teaching. These formative experiences as students are a "major influence in shaping teachers' conceptions of the teaching role and role performance" (Zeichner & Gore, 1990, p. 333). The strength of these early learning experiences or pre-preservice experiences of teachers has often been cited as one of the primary reasons for the general lack of change in instructional approaches over time, accounting for the persistence of traditional forms of pedagogy (Zeichner & Gore, 1990).

Since Lortie's claims, more recent literature also makes similar assertions regarding the persistence of traditional teaching methods despite efforts of reform-oriented teacher preparation programs. The personal knowledge teachers bring to their preparation includes many images and beliefs about what good teaching is based on their own experiences as students (Beijaard, Meijer, & Verloop, 2004; Darling-Hammond, 2006; Eick & Reed, 2002; Pajares, 1992; Windschitl, 2004). These studies lend support to the notion that the beliefs teachers hold about teaching and learning, and the instructional practices used in their classrooms are largely shaped by their experiences prior to formal teacher training.

Eick and Reed (2002) conducted a multi-case study of 12 secondary science student teachers during their student teaching placements. The goal of this study was to determine how

personal histories played a role in the formation of early role identities as science teachers influencing the practices used during their student teaching placements. Their analysis used field notes, observations of practice, guided reflections, and interviews to focus on teachers' personal histories and identity to understand how these two constructs combine to either help teachers incorporate an inquiry-based pedagogy into their practice learned in preservice training or to resist this pedagogy, and instead favor images and beliefs from their personal histories. The results of the study focus on two teacher cases, Sherry and Carey. Sherry was successful in her frequent use of inquiry-based instruction and was highly reflective. Carey used mostly traditional, didactic practices, and struggled to implement student-centered activities promoted in the teacher preparation program. As a part of Sherry's personal history she described both positive and negative experiences as a student, her own need to learn through more constructivist practices, and a positive role model who inspired her to take up this type of pedagogy. This history better supported her image of herself as an inquiry-oriented teacher more so than Carey. Carey's personal history included learning best herself from traditional teaching styles, and images of positive role models that were more traditional themselves. She was not able to identify with an inquiry-oriented teacher role. Eick and Reed (2002) conclude new teachers' role identities are formed by experiences as a student, teacher role models, previous teaching experiences, and other prior experiences (p. 402). The authors argue that preservice teachers with stronger role identities are better able to enact their vision of teaching and are less likely to conform to other pressures in the school context. They suggest that teachers need strong role identities for inquiry-based teaching in order to successfully implement this in the classroom.

It is interesting to note that in the above-mentioned study, not all teachers were found to replicate the more traditional teaching practices inherent in their prior learning experiences or

personal histories with science. Some teachers, such as Sherry, were largely compelled to use more reform-based teaching practices because of the negative experiences with traditional teaching practices that dominated their learning experiences as students in both the high school and undergraduate setting. Studies such as this suggest the socialization of teachers may not be solely predetermined by personal histories as Lortie and others have suggested. Both negative and positive experiences with school as a high school student and undergraduate can promote a belief in, and enactment of, more reform-based instruction.

### **Knowledge of content**

Shulman (1987) stated, “to teach is to first understand” (p. 14). Teachers gain much of their understanding of the secondary science content to be taught prior to any professional training in learning to teach. Often referred to by various names such as content knowledge, common content knowledge (CCK), and subject matter knowledge (SMK), this understanding has been determined to play a critical role in the quality of instruction that takes place in the classroom (Ball, Thames, & Phelps, 2008; Davis et al., 2006; Shulman, 1987; Zeidler, 2002). Zeidler (2002) described the understanding of content or SMK as “a teacher’s quantity, quality, and organization of information, conceptualizations, and underlying constructs in their major area of study” (p. 31). Shulman (1987) argues that in order for teachers to effectively instruct a diverse population of students they “must have a flexible and multifaceted comprehension, adequate to impart alternative explanations of the same concepts or principles” (p. 9). Ball et al., (2008) describe this type of knowledge as “common” in the sense that it is necessary for teaching, but it is not “unique” to just the work of teachers. This type of subject matter knowledge finds applications across a wide variety of settings related to the field of study. Though it is clearly logical to assume that one must first understand secondary science content in

order to be able to teach it, what is not as clear is the role that content knowledge plays in the effective use of reform-based teaching practices.

In his early work on describing a knowledge base for teaching, Shulman (1987) posited strong teacher content comprehension was “most critical for an inquiry-oriented classroom than for its more didactic alternative” (p. 7). Several studies have indicated a link between the strength of a teacher’s content knowledge and the use of reform-based teaching practices in the classroom. Crawford’s (2007) study proposed a possible association between stronger science content knowledge and the increased use of inquiry-based teaching practices. Crawford’s study followed five prospective secondary science teachers from the same teacher preparation program through their yearlong student teaching internship. She found these five preservice teachers employed a wide range of teaching strategies from traditional practices to full inquiry practices. Her analysis contrasts the practices of two of the teachers, Jason and Helen, who fall at opposite ends of the spectrum with regards to their understanding of, and implementation of, inquiry-based teaching methods. Helen is the most traditional in her approach to teaching out of the study sample, while Jason was deemed to use the most inquiry-based practices throughout his internship. Though Crawford attributes the differing levels of inquiry-based teaching practices among the teachers to their beliefs of teaching and learning, she speculates that their level of subject matter expertise could be a possible explanation as well. Jason was an honors student in his subject matter, and demonstrated a depth of content knowledge and comfort with the science content. Helen on the other hand, struggled with the subject matter feeling that she was in “survival mode” most days. Crawford states the differences noted in practice “might be explained by their different epistemological views (knowledge about their discipline), rather than simply their views of learning or their views of subject matter” (p. 636).

Roehrig and Kruse (2005) also asserted a relationship between level of content knowledge and use of reform-based teaching practices. Their mixed-method study examined the role of reform-based curricular materials in influencing the classroom practices of 12 high school chemistry teachers, and the role that their knowledge and beliefs played in the implementation of the reform-based chemistry curriculum *Living by Chemistry*. The authors found the teachers' beliefs play a significant role in teachers' classroom practices and their implementation of the reform-based curriculum; however other factors were important as well. When interviewed about their classroom practices, teachers' frequently spoke of their content knowledge in relation to their practice. Teachers in this sample who were teaching outside of their primary discipline or field, identified by the researchers as those with a minor or less in chemistry, reported their ability to plan and implement inquiry-based chemistry lessons was constrained by their lack of, and comfort with, chemistry knowledge. The authors concluded, "in spite of holding reform-based teaching beliefs and knowledge of inquiry-based instruction, these teachers appeared to lack the content knowledge to plan and enact reform-based chemistry lessons (p. 421). Shulman (1987) reported similar findings in his case study of Colleen, a secondary English teacher. The types of teaching styles that Colleen employed in her classroom drastically shifted from primarily student-centered when she was comfortable and knowledgeable about the content to primarily teacher-centered when she taught topics she lacked a depth of knowledge about. Shulman concluded "there are powerful relationships between comprehension of a new teacher and the styles of teaching employed" (p. 17).

Though strong content knowledge appears to be an important component of effective teaching, its direct link to reform-based teaching is still unclear. Other research findings have questioned the conclusions about this relationship. Enyedy, Goldberg, and Welsh (2006)

studied two veteran middle school science teachers (one who self identifies as a math teacher and the other who identifies as a science teacher) who both attended a professional development workshop on implementing an inquiry-based environmental science curriculum. The authors set out to understand how the teachers implemented the curriculum after the training workshop. Their findings are based primarily on interviews with teachers and recordings of their teaching practice. The teachers also participated in interviews in which they were shown parts of their own teaching and then asked to describe why they made their instructional decisions. Results showed the two teachers implemented the curriculum in their classrooms in very different ways, and student outcomes were also different among the teachers. Mrs. Cook, the math teacher teaching science, (who students performed better on the environmental science test) related all activities to each other, tried to get students to generate ideas about how to explore questions, and became more of a co-inquirer with the students. Ms. Whyte, the science teacher, used the activities in isolation from one another, had students follow protocols closely, and was more of the authority in the classroom. In this case, the teacher with less science content knowledge was more successful in implementing reform-based science lessons with her students.

Though the literature is varied with regards to how subject matter knowledge is associated with the use of reform-based teaching practices, it is clear that subject matter knowledge is an important component of teaching. Most, if not all of the above scholars would agree that content knowledge is just one component of a broader base of professional knowledge that teachers need to teach effectively. As Zeidler (2002) stated, “a teacher’s SMK may be a necessary but insufficient condition for the transfer of central ideas, precepts, tenets, and underlying thematic concepts for a given discipline to be made accessible to his or her students” (p. 31). Shulman (1987) proposed an initial model of a professional knowledge base

for teaching. Though he stresses the importance of content knowledge as the first part of this model, there are other types of knowledge that are equally if not more important in his model. Shulman states, “the knowledge base for teaching lies at the intersection of content and pedagogy” (p. 15). It is this model that Ball et al., Zeidler, and countless other scholars have taken up to help understand the nature of exemplary teaching practices. Though the personal histories of teachers and the content knowledge they possess are often beyond the reach of teacher educators, the interaction of these personal background variables with teachers’ professional preparation may lead to the types of instructional practices teachers take up.

### **Professional Backgrounds**

Another background characteristic that influences the socialization of teachers is the professional preparation teachers take part in. Currently, most teachers are prepared through traditional teacher preparation programs in more than 1,300 public and private colleges and universities (Boyd et al., 2007; Wilson, Floden, & Ferrini-Mundy, 2001). A much smaller proportion of teachers enter the field through alternative pathways that streamline the certification process, though this number is rising and many are seeking to expand these alternative avenues to teaching (Darling-Hammond, Chung, & Frelow, 2002). Given that most teachers are still prepared and certified through traditional university based preparation programs, and the sample for this study were all graduates of university-based teacher preparation, the focus of the literature review on professional preparation is based on this pathway into teaching.

### **Impact of teacher preparation**

The set of knowledge and skills needed to teach is developed over a continuum of educational experiences of which preservice teacher education is the beginning (Darling-



Hammond & Baratz-Snowden, 2005; Feiman-Nemser, 2001). During the process of teacher socialization across this continuum, formal teacher preparation is thought to serve as a keystone connecting and refining the beliefs and ideals teachers already possess about teaching with the necessary pedagogical knowledge and skill to enact practices upon graduation that mirror the best practices learned during preparation. However, formal teacher preparation has been criticized for its inability to overcome the past, and adequately prepare teachers for their future contexts. As noted above, teachers' personal histories and content knowledge frame some of the earliest socialization experiences for teachers. Some scholars have argued these personal background experiences are most significant to the overall socialization of teachers and trump the influence that teacher preparation has on teachers' practices (Lortie, 1975; Zeichner & Gore, 1990). Teacher education has also been argued to be "impotent" as a factor in socializing teachers due to the fractured or segmented nature of many teacher preparation programs (Zeichner & Gore, 1990). Brouwer and Korthagen (2005) summarize this perspective on the impact of teacher preparation on teacher practice stating, "teacher education provides a stressful, ineffective interlude in the shift from being a moderately successful and generally conformist student to being a pedagogically conservative teacher" (p.156).

However, other researchers challenge this notion. Scholars claim programs that are structured in a manner that creates strong coherence between program experiences and coursework as well as integrate reflective practices throughout the preservice experience can best serve to help preservice teachers connect theory to practice. Further, such practices aid preservice teachers in integrating this knowledge into their classroom practice (Brouwer & Korthagen, 2005; Darling-Hammond, 2006; Grossman, Valencia, Evans, Thompson, Martin, & Place, 2000; Kennedy, 1999) and help teachers to connect their subject matter knowledge to their

pedagogy, developing a pedagogical content knowledge needed to effectively teach (Ball, Thames, & Phelps, 2008). Brouwer and Korthagen's 2005 large scale longitudinal study sought to understand to what degree reform-oriented teacher preparation programs can make a difference in their graduates' eventual teaching competence, and the degree to which teacher preparation can "counterbalance" the socialization of teachers to use the practices most prevalent in the school contexts in which they go onto teach. This mixed-methods study analyzed data from 357 teachers, graduates of 24 different graduate teacher education programs, as well as information from 128 cooperating teachers and 31 university supervisors. The researchers used both a multivariate regression analysis and interviews of a representative subsample of the participants to examine the relative influence of the teacher preparation programs and the socialization of the school context on teachers' practices. Results showed that the teachers' practices in their first year of teaching did appear to be influenced by their socialization into the school context. However, in their second year of teaching, the practices that teachers had learned and used in their preservice programs resurfaced. The researchers concluded the teaching competences expressed in teachers' second year practices went through a "latency period." Due to the nature of their analysis, Brouwer and Korthagen were able to go beyond just making the claim that teacher preparation does influence beginning teachers use of practices aligned with the reform-oriented preparation, but were also able to detail which programmatic features were most relevant. These features are (a) the gradual increase in complexity of student teaching activities; (b) the cooperation among student triads, cooperating teachers, and university supervisors; and c) the alternation of student teaching and college-based periods (p.213). This study lends support to the argument that teacher preparation can influence teachers to use practices associated with the philosophy of their preparation programs, and can work to offset the effects of socialization

related to school context. It also provides details about possible structural components of teacher preparation that might matter more in this association.

Despite the varied findings in the literature regarding the impact of formal teacher preparation on the socialization of teachers and their eventual classroom practice, Zeichner and Gore (1990) identify three main components of teacher preparation that can possibly influence the socialization of teachers: (a) general education and academic specialization courses completed outside of schools, departments, and colleges of education; (b) methods and foundations courses usually completed within education units; and (c) field-based experiences usually carried out in elementary and secondary school classrooms (pp. 335-336). The role of these three teacher preparation components is to help teachers develop a knowledge base of teaching and skill for teaching. The National Academy of Education 2005 report, *A good teacher in every classroom*, finds teachers must acquire three main areas of knowledge during their preparation: 1) knowledge of learners and how they learn and develop within social contexts, 2) understanding of the subject matter and skills to be taught in light of the social purposes of education, 3) understanding of teaching in light of the content and learners to be taught, as informed by assessment and supported by a productive classroom environment (Darling-Hammond & Baratz-Snowden, 2005, p.5). Feimen-Nemser (2001) points to several central tasks of preservice preparation in order to build this base of knowledge. She posits throughout their preparation pre-service teachers need to: 1) examine their beliefs critically in relation to visions of good teaching; 2) develop subject matter knowledge for teaching; 3) develop an understanding of learners, learning, and issues of diversity; 4) develop a beginning repertoire; and 5) develop the tools and dispositions to study teaching (p. 1050). It is through the development of this base of knowledge of teaching and learning the role of a teacher that teacher

preparation is thought to influence the process of a teacher becoming part of the profession and culture of teaching.

### **Teachers' beliefs**

The beliefs teachers hold about learning and teaching receive a great deal of attention with regards to their relationship with the kinds of instructional practices teachers enact in the classroom. Though not specifically mentioned in the framework for socialization theory, the nature of developing the values and attitudes of the teaching profession implies the beliefs construct of teachers' plays a role in their socialization. Beliefs have been defined in the literature as one's deeply held personal views, based on evaluation and judgment, and often unaffected by persuasion (Pajares, 1992). The beliefs that one holds are suggested to be ideas about the world thought to be true based on personal experiences including feelings and memories of the experiences (Nespor, 1987; Richardson, 1996). Beliefs have been shown to be rigid or hard to change, this is especially true the earlier the belief is incorporated into a person's belief system. In order to try to change previously held beliefs about good teaching, beliefs need to be proved unsatisfactory and challenged before they can be incorporated into a person's belief structure (Pajares, 1992).

Simmons et al. (1999) argue the complexity of trying to change teachers' practice to reflect more current reform efforts, which requires teachers to "rethink teaching and learning" (p. 949). In order to "rethink teaching and learning" teachers need to overcome their previously held beliefs about what counts as effective teaching and learning to form a vision more aligned with constructivist principles at the heart of science education reform (Anderson, 2002). Helping teachers form this vision, or beliefs system, aligned with these principles and translating these beliefs into practice poses great challenges for those involved in all aspects of teacher

development, and thus has been a prominent focus of much of the research in the field of science education. Jones and Carter (2007) go as far to state that “attitudes and beliefs are key to understanding and reforming science education” (p. 1067).

Anderson and Helms (2001) argue, “Fundamental reform of this nature requires significant changes in teachers’ values and beliefs about science education” (p. 7). The importance of understanding teachers’ beliefs about learning and teaching is due to the proposition that the beliefs of preservice teachers play a role in developing their knowledge of teaching and their future behaviors (Pajares, 1992). It is argued that understanding the beliefs that teacher’s hold is also important because of the growing research-base that shows beliefs impact teaching practices (Haney, Czerniak, & Lumpe, 1996; Jones & Carter, 2007, Richardson, 1996; Roehrig & Kruse, 2005, Savasci & Berlin, 2012). The driving force of much of this research is the assumption of a direct link between beliefs and practices: if we can modify teachers’ beliefs to become more reform-oriented, then these beliefs can translate into changing their practice. Jones and Carter (2007) point out researchers in support of this notion argue that “significant changes in teachers’ instructional practices come only after there are fundamental changes in teachers’ belief systems...[though] there may be a lag time between changes in beliefs and changes in practices” (p. 1082). In general, research does support the notion of a link between beliefs and practices (Jones & Carter, 2007; Mansour, 2009). Yet the relationship between beliefs and practices is certainly not straightforward and is open to debate (Mansour, 2009). Some have speculated that perhaps a change in behavior or practice is what precipitates a change in beliefs (Waters-Adams, 2006). In an attempt to better understand the relationship between beliefs and practices, some argue for a more holistic stance to understanding teacher development. Korthagen (2004) created an onion model detailing the levels of change in which

teachers can be influenced. This model takes into account the environment, behavior, competencies, beliefs, identity, and mission of the teacher. Korthagen suggested one might view the inner most layers of the onion (mission, identity, and beliefs) as working outward and influencing the outer layers as well as the reverse with the outer layers (environment, behavior, and competencies) influencing beliefs and identity. This model allows room for further exploration of the dynamic relationship of beliefs and practices, and takes into account the role socio-cultural context plays in this relationship

Though there is still much to be learned about how beliefs impact practice, scholars still agree this is a worthy construct to consider when trying to explain the practices teachers use in the classroom (Jones & Carter, 2007; Mansour, 2009). Anderson (2002) describes internal barriers or “dilemmas” that must be overcome for teachers to learn to teach using reform-based practices. He claims these dilemmas or teachers’ beliefs can threaten a teacher’s ability to enact a more reform-based pedagogy. Previous research has shown that part of this internal barrier to creating a vision of reform-based teaching is the powerful beliefs about teaching and learning preservice teachers bring with them from their own classroom experiences as a student or teacher (Bryan, 2003; Cronin-Jones & Shaw, 1992; Eick & Reed, 2002; Feiman-Nemser, 2001; Richardson, 1996; Simmons et al., 1999). Reform efforts call for teachers to supplant long held views of traditional classrooms with a vision of good teaching that teachers have not experienced themselves. Yet, research has also found that even teachers with sophisticated reform-based beliefs are unable to put their visions of good teaching into action (Davis et al., 2006; Simmons et al., 1999; Haney, Lumpe, Czerniak & Egan, 2002).

The literature on beliefs continues to shed light on the beliefs that teachers hold about science teaching, and the implications these beliefs have for practice. Simmons et al. (1999), in a

study of beginning teachers, found many beginning teachers have student-centered beliefs, yet these beliefs were not stable over time and their practices reflected teacher-centered actions. Haney, Czerniak, and Lumpe (1996) conducted a study of 800 randomly selected in-service teachers from Ohio to determine what factors influenced teachers' intentions to implement four strands of Ohio's science model, which is based on the current national science education reform documents. The authors found that "attitudes toward behaviors had the most influence on whether teachers intended to implement the strands of the science model into their classroom" (p. 984). The authors conclude that reform efforts cannot ignore the importance of beliefs because "teachers' beliefs are significant contributors of behavioral intention" (p. 985). Hammerness (2003), in a small qualitative study of teachers' visions, found that understanding the visions that teachers hold about good teaching can help to explain the "reality shock" or gap that is often found between beginning teachers' beliefs and practices. She suggests, that "by asking teachers to describe their vision, teacher educators could develop a powerful new means to surface the insights that drive teachers' work" (p. 53). Gaining an understanding of what kinds of beliefs preservice teachers hold as they enter their preservice preparation can in turn help teacher educators to create learning experiences to guide their development as a teacher.

It is apparent that the beliefs teachers hold are instrumental in understanding their practice, but shifting teachers' beliefs to be more aligned with the vision of reform is a challenge for teacher preparation. Particularly as teacher preparation must serve as the link between the past and the future, the challenge lies in dealing with the beliefs teachers already hold about teaching and learning as well as acknowledging the challenges these beliefs will go under in the context of teaching. The culmination of experiences from years of being a student results in beliefs about good teaching based on these experiences (Darling-Hammond, 2006, Lortie, 1975).

Teachers need the chance to confront their beliefs about teaching during their teacher education programs. Feiman-Nemser (2001) asserts it is critical that teacher educators provide teachers with experiences within their preparation that allow them to critically examine their entering beliefs, and guide them to create a new vision of teaching so that these new beliefs will continue to help shape their ideas and practices. “Teachers can be effective guides for students learning science only if they have the opportunity to examine their own beliefs” (NRC, 1996, p. 28). In an evaluation of teacher preparation programs, Tatto (1998) makes the same recommendation that “reflecting and attempting to understand how teacher beliefs influence their teaching are critical to teachers’ development and change in role conceptions and teaching practices” (p. 66).

The literature details evidence of the effectiveness of preservice preparation programs in helping teachers to confront their previously held beliefs about teaching, and also in helping teachers construct a vision of good teaching that is more aligned with what is known about best practices. Some research has shown that belief systems remain virtually unchanged despite teacher preparation programs. Cronin-Jones and Shaw (1992) studied the beliefs of both elementary and secondary preservice science teachers before and after completion of a science methods course. They found that although secondary preservice teachers’ beliefs were not as simple in nature as the elementary preservice teachers, both groups did not change the overall organization of their beliefs about teaching. Stuart and Thurlow’s (2000) study of a mathematics and science elementary methods course designed with specific attention to explore and challenge teachers long held beliefs found that many of the preservice teachers had a more refined understanding of the role that their beliefs may have on their decisions and actions as teachers. The preservice students in this methods class were found to “consciously understand and reexamine the effects of these beliefs on their decision making about classroom practice” (p.



119). Tatto's (1998) study concluded that teacher education programs with specific components (well defined philosophy, small size, coherent norms guiding curriculum development and implementation, context-relevant opportunities to learn, learning communities, and faculty that share a common vision) have an impact on pre-service teachers' beliefs. Similarly, more recent research has shown preparation programs that are focused on science specifically, and contain more than one methods course can better influence reform-based beliefs and practices (Roehrig & Luft, 2006). A longitudinal study conducted by Swars, Hart, Smith, Smith and Tolar (2007) with elementary preservice math education students also suggested teacher preparation can have an impact on beliefs. "During their coursework, preservice teachers developed beliefs more consistent with a reform perspective and became more efficacious about their skills and abilities to teach mathematics effectively and to influence student learning" (p. 333). The authors attributed the stability of preservice teachers' beliefs during the program including student teaching to the specific features of the program (two methods courses and time-intensive field placements). Swars et al. (2007) point out that their research lacks an understanding of the program's influence as teachers enter their own classrooms. In Kennedy's (1999) study of the influence of teacher preparation on preservice teachers, she refers to the frames of reference from which preservice teachers filter new knowledge about teaching into their current beliefs and translate this to enactment. She suggests, "students might be persuaded to change their frame of reference and yet be unable to enact these new ideas because they do not have enough behavioral understanding of these terms to enact them. Or students might learn both a new frame of reference and a set of enactment of these new ideas" (p. 72). Her study found that it was possible to help some teachers shift their frame of reference and envision a different enactment

based on this new frame. Kennedy claims that a reform-oriented vision or mission of the teacher education program is instrumental in creating this shift.

### **Sphere Two: The Local Context**

In the process of teacher socialization, the workplace, or the local school context in which teachers become part of a professional community, is found to exert significant influence on the their teaching practices. Zeichner and Gore (1990) state “there is very strong evidence, for example, that when attempts are made to train prospective teachers in the performance of specific teaching skills through microteaching and other systemic procedures, the continued use of the skills by prospective teachers outside of the laboratory is highly dependent upon whether the ecological conditions in specific classrooms are conducive to the use of the skills” (p. 336). Hargreaves (1988) explains that much of what is seen in teaching practices is a result of social processes of learning to teach. He claims “teachers do not just decide to deploy particular skills because of their recognized professional worth and value, or because of their own confidence and competence in operating them. Rather they make judgments about the fit between particular skills, constraints, demands, and opportunities of the material environment of the classroom; about the appropriateness of particular styles or techniques for present circumstances” (p. 219). More recent literature makes similar claims regarding the influence of school context. In a study of teachers’ use of writing practices, Grossman et al. (2000) conclude “aspects of school and district context can support or thwart continuing learning and fuller appropriation of ideas and practices for teaching” (p. 660). Gaining an understanding of how teachers make sense of their work environment is important to understanding their quality of teaching.

## **Transition from Preservice to In-service**

As new teachers transition from their preservice training to their teaching career, they start to become integrated into the school community and as a result their teaching goals and practices are often altered (Saka, Southerland, & Brooks, 2009). Feiman-Nemser (2001) describes this change as a “shift in role orientation and an epistemological move from knowing about teaching through formal study to knowing how to teach by confronting the day-to-day challenges” (p. 1027). The kinds of challenges that teachers may face during their early careers or induction phase are dependent on the school culture in which they socialized. For many teachers this transition from preservice to professional teacher is wrought with tension. Veenman (1984) described this tension new teachers experience as they are socialized in school environments as “reality shock” (p. 143). This reality shock may lead to teachers to set aside the ideals formed during their preservice training due to learning to cope with the varying levels of possible constraints faced in the school environment. Feiman-Nemser (2001) also portrays the impact of this reality shock in her descriptions of the specific needs and challenges of teachers in their early careers. She depicts the induction phase for teachers as “sink or swim” as this phase often pushes teachers to fall into a pattern of teaching practices for survival regardless of whether or not these are “best” practices (p. 1014).

Veenman (1984) recognized situational causes as one possible reason teachers experience reality shock. Situational causes may be related to problematic school situations, lack of materials or supplies, isolation in the workplace, lack of well articulated objectives, pressure from parents, and inadequate staffing (p. 147). Viewing the way in which teachers change in their early careers as a function of the socialization process focuses on “the interplay between individual needs, capabilities, intentions, and institutional constraints” (p. 162). There are a

variety of dilemmas or constraints that teachers often express that are related to the transition from preservice to professional teacher. Often teachers convey a tension between the ideal of what standards-based reforms portray for instructional practices as well as the pedagogical preparation from their preservice program and the realities of their classroom (Anderson & Helms, 2001). This tension often leaves teachers feeling inadequately prepared to try new ways of doing things in their classrooms (Anderson & Helms, 2001). Having a strong sense of preparedness to teach can be an important factor in a teacher's use of effective teaching practices. Previous research has found that teachers who graduated from quality preparation programs reported a higher sense of preparedness to teach and also a higher sense of efficacy for their practices. For example, using a survey of 2,956 teachers in New York City, Darling-Hammond, Chung, & Frelow (2002) found teachers who felt better prepared were significantly more likely to believe they could reach all of their students, handle problems in the classroom, teach all students to high levels, and make a difference in the lives of their students. This sense of preparedness to teach may indeed be an important factor in resolving some of the reality shock new teachers' experience.

The degree to which the constraints of the environment affect the practices of new teachers can be dependent on how discrepant the school reality is to the ideals teachers formed as a result of the preservice training. The more teachers experience a disparity between the two, the more conservative and authoritarian they become in their attitudes and behaviors (Veenman, 1984). Other factors such as not having enough time to teach everything required (Adams & Krockover, 1997; Anderson & Helms, 2001) and struggles with discipline and classroom management, rank high among the classroom realities that new teachers contend with (Davis, Petish, & Smithey, 2006; Flores & Day, 2006; Veenman, 1984). Another dilemma that teachers

face is how to contend with equitable practices in the classroom so that quality science instruction is for all students. The student population often influences the kinds of instructional practices teachers use. Reform-based instructional practices are frequently reserved for the high achieving, “more willing or able students” while the less able or interested students are perceived to not be able to participate/achieve with this type of instruction (Anderson & Helms, 2001).

Hargreaves (1988) noted “all teaching takes place of the context of opportunity and constraint” (p. 219). The “situational constraints” that teachers face during this time of reality shock may lead to different coping mechanisms that become realized in their teaching practices. These coping practices “can become so habitual, so routinized, that they seem like coping no more, but worthwhile and valid teaching (Hargreaves, 1988, p. 219). In a study of student-teacher socialization, Lacey (1977) describes three “social strategies” teachers in engage in found to use in response to the demands, constraints, or pressures experienced in situations within an institution or workplace. He identifies these three strategies as: (a) “*internalized adjustment*, in which the individual complies with the constraints and believes that the constraints of the situation are for the best; (b) *strategic compliance*, in which the individual complies with the authority figure’s definition of the situation and the constraints of the situation, but retains private reservations about them; and (c) *strategic redefinition* of the situation implies that change is brought about by individuals who do not possess the formal power to do so. They achieve change by causing or enabling those with formal power to change their interpretation of what is happening in the situation (p. 72-73). Lacey’s development of these strategies view individuals as having autonomy to make choices, and select a strategy (whether consciously or subconsciously) in response to changing situations they are placed in. He critiqued previous research predicated on a more functionalist view of socialization, with his study aligning with a

more interpretive view of socialization in that teachers can, and sometimes do, have influence on their socialization into teaching.

### **Influence of School Climate/Culture**

Windschitl (2002) articulates a framework of four “dilemmas” that influence whether or not teachers fully understand or implement practices that are congruent with the tenets of constructivist learning theory. These dilemmas are described as “aspects of teachers’ intellectual and lived experiences that prevent theoretical ideals of constructivism from being realized in practice in school settings” (p. 132). One of the four types of influences, cultural dilemmas, particularly relates to the socialization pressures that teachers experience in the workplace, especially in their early careers. He explains that “dominant” or “entrenched” school cultures may encourage teachers to move farther away from the constructivist philosophy and towards practices in which the teacher is in more control of the learning environment (pp. 150-151). Cherubini (2009) further defines this notion of school culture as “a distinct entity in each school” which works to influence how teachers perceive their role and ways in which they will function in and contribute to the school and hence their socialization as a teacher (p. 83).

In an analysis of the impact of school context/culture on the socialization of teacher practices it is important to include an understanding of the potential influence of colleagues and of evaluators, or administrators (Hargreaves, 1998). Windschitl (2002) refers to this influence as political dilemmas teachers must contend with that may result from how power is distributed among the different players in the school community. How much of this political power is exerted on teachers’ abilities to make choices regarding curriculum, methods of instruction and assessment, and use of resources can also influence the realization of constructivism in practice. Anderson and Helms (2001) review of multiple school case studies found that more collegial

support and collaboration could significantly influence teachers' beliefs and practices. The authors state the most powerful influence for reforming science instruction identified was "collaboration among teachers in the day-by-day work context" (p.8). Alhija and Fresko (2010) investigated the relationship between teacher satisfaction with their socialization into their school and various school level and personal variables. Using a regression analysis of data collected from 243 teachers, the authors found that collegial support, receiving support from a mentor, and help from the principal significantly predicted the variance in teacher satisfaction with their socialization. Not only can these supports affect teachers' satisfaction, but they can also impact the decision-making and authority that a teacher has over the curriculum (Windschitl, 2002). Without supportive leadership, teachers often feel that they must conform to the socialization pressures of the school culture. Luft et al. (2011) summarize the impact that leadership can have on the socialization of teachers stating, "administrators set the stage for the work of colleagues and mentors, and are critical in creating the environment that will socialize new teachers. The basic decisions they make regarding the new teacher will be some of the most important to the new teacher" (p.1220). It is therefore important to look at the individual and collective impact that colleagues and administrators have on shaping new teachers' practices.

Several studies have highlighted the importance of school culture on teacher socialization. McGinnis, Parker, & Graeber (2004) investigated the induction of five upper elementary/middle level beginning math and science teachers over the course of two years. The focus of the study was to understand what happened to both teachers' beliefs about teaching and teachers' instructional practices after graduating from a reform-oriented preservice program. Upon analyzing observations of practice and interviews, the researchers concluded school culture was a major factor in determining whether these teachers implemented reformed-based

mathematics or science teaching. The authors stated “although teacher preparation could send forth beginning mathematics and science teachers who were reform-minded, the primary limiting factor as to the long-term extent and success of the beginning teachers in enacting reform was their perception of their school cultures” (p. 743). Flores and Day (2006) also investigated school culture, but in relation to how the identities of new teachers were shaped over the course of their first two years of teaching. A majority of the teachers in their sample (9 of 14) experienced some level of constraints on their practice during their early teaching career. The researchers found the teachers became more rule-oriented and less creative in their teaching over time due to the pressures from the school culture. The study concluded “the influence of workplace (positive or negative – perceptions of school culture and leadership) played a key role in (re)shaping teachers’ understanding of teaching, in facilitating or hindering their professional learning and development, and in (re)constructing their professional identities” (p. 230). Smaller case studies of one or two teachers also found similar results regarding the influence of school culture on altering teachers beliefs and practices in the early stages of their careers (Munby, Cunningham, & Lock 2000; Saka, Southerland, & Brooks, 2009).

The kind of opportunities for continued learning about teaching is another part of the local context that shapes the socialization of teachers. Teachers’ participation in quality professional development is influenced by the professional culture of the district and the emphasis administrators and the school/district’s policies put on in-service education (Achinstein, Ogawa, & Speiglmán, 2004). The amount and types of professional development can be an important component for instructional change for both early career teachers and experienced teachers. It has been argued that this continual learning for teachers is the “key to improving the quality” of schools in the United States (Desimone, 2009, p. 181). Desimone



outlines five critical features of professional development learning opportunities; 1) having a content focus, 2) engages teachers in active learning, 3) is coherent with teachers' knowledge and beliefs as well as being consistent across school and district policies, 4) is of sufficient duration, and 5) requires collective participation of teachers from the same school. It is important to consider how these features of professional development interact with other school context variables to support the use of reform-based instructional practices.

Feiman-Nemser (2001) identifies one of the central tasks of learning to teach is for teachers to learn the context (knowledge of the students, curriculum, and school community) in which they will further their knowledge and practice of teaching. This knowledge of the context of schools is necessary in order for teachers to become integrated into the school community (Davis, Petish, & Smithey, 2006). It is therefore important to understand how the socialization into unique school contexts and cultures impacts an individual teacher's beliefs and practices (McGinnis, Parker, & Graeber, 2004).

### **Sphere Three: State Policy Environment**

The broader context of the state policy environment may also shape the socialization of teachers. As previously discussed, various participants in the local context play a role in the socialization of teachers, influencing the types of instructional practices teachers implement. District policies play a role in directing the kinds of professional learning opportunities that teachers (particularly new teachers) have to continue to learn about teaching (Grossman & Thompson, 2004). Administrators at the district and school levels are influenced directly by the policies of the state to which they are accountable. Research has suggested that policies set forth by states in the current standards-based, accountability driven policy, environment can influence teacher practice (Achinstein, Ogawa, & Speiglmán, 2004). Analysis of teacher

socialization must attend to this broader context because what happens in the classroom is a “product of policy decisions, political actions, and other influences at levels beyond the classroom” (Zeichner & Gore, 1990, p. 339).

### **Current Policy Environment**

Standards-based reform emerged in the 1990s as an educational movement to achieve high-standards for all through changes to the curricula and instructional techniques for the classroom. “It is a process-driven conception of educational change that explicitly links schooling inputs and policy drivers to student outcomes through clearly defined mechanisms” (Swanson & Stevenson, 2002, p. 3). National reform documents such as those from the AAAS and the NRC depicted what these standards of reformed curriculum and instruction should look like in science education. One of the primary goals of these standards and the models put forth was to lay out a curriculum framework detailing the specific science concepts students should know and scientific practices they should be engaged in.

The decentralized nature of the United States education system, which gives states much of the decision-making power regarding how to achieve high standards, has led to a varied landscape of how individual states choose to respond to meet the challenge of high standards for all. Swanson and Stevenson (2002) contend among the variation in state responses, four common policy drivers emerged at the core of the agenda for change: (a) content standards detailing the academic material students should learn, (b) performance standards establishing levels of content mastery students should be able to demonstrate, (c) aligned assessments for statewide testing to measure students’ level of performance on specified content, and (d) professional standards for the training and certification of teachers to ensure they are skilled to enact the high-standards curriculum (p. 4). The standards-based reforms also ushered in the

accountability-based reforms. The No Child Left Behind (NCLB) legislation of 2002 was issued to ensure states hold districts and schools accountable for meeting high standards for all students through the use of standardized statewide assessments. A school's performance on these accountability measures is tied to their ranking and decisions regarding school funding (Southerland, Abrams, & Hutner, 2008). The standards-based and accountability-based reforms work in concert to shape the policies of districts regarding curriculum, assessment, and professional learning opportunities for teachers. Through this channel policies that are set at the state level trickle down to impact the instructional practices of classroom teachers. Woodbury and Gess-Newsome (2002) argue the district interpretation of policy reform intentions, along with the district demographics and structure of control within the district, form "unique contexts of reform that influence the daily work of individual teachers and students" (p. 767).

### **Policy and Practice**

The standards-based reforms have been described as providing a much-needed structure for delineating the necessary subject specific concepts students should know. The standards are seen as a way to provide consistency in what is taught within and across schools, and offer a guide for teachers about what to include in their instruction (Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003). Though there have certainly been positive ramifications of creating common high standards for teachers and students, researchers have also found these standards have a negative impact on teachers and students. Regardless of the teachers' own personal standard for learning and teaching, they may reject more intellectual pedagogical practices in favor of more scripted curriculum practices that will secure a minimal level of student performance on accountability measures (Cherubini, 2009; Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003). Windschitl (2002) argues the "work of teachers is becoming more routinized as state and

local school systems increasingly implement standardized curricula and use standardized tests to assess performance of students, teachers, and schools” (p. 155). The impact these policies have to drive the nature of school culture, and hence the work of teacher, is evidenced by research on how new teachers are inducted into schools in their early careers.

The increase in standardized testing required by recent policy reforms as a form of accountability for student learning exerts pressures on teachers from schools and parents for the students to score well (Anderson & Helms, 2001). Cherubini (2009) argues in school cultures where this type of measure of student learning is prioritized “the anxiety of novice teachers’ socialization process into school culture is further complicated by a burden to assimilate their practice and conceptualize their paradigms to the school’s occupational purposes” (p. 93). Other researchers have found this to be true for reform-minded science teachers as they are socialized into their early teaching careers. As previously described, McGinnis, Parker, & Graeber (2004) conducted a case study of five mathematics and science teachers who had recently graduated from a reform-oriented teacher preparation program to understand how teachers’ practices were impacted by the schools they were inducted into. The researchers described affordances and constraints of the school culture that determined whether teachers implemented reform-based mathematics and science teaching. While the affordances described by the teachers were more unique to each school, the constraints teachers discussed in relation to their practice were more shared. Common constraints on practices were the pressures from standardized testing, prescribed curriculum, and the overall perception that the major role of the teacher was to achieve increased student performance on the tests. These pressures on teachers worked to constrain the types of reform-based instruction they implemented in their classroom.

Scholars have also suggested that these types of pressures directly shape teachers instruction. As a result of school and district responses to state accountability measures, the teachers' need for students to achieve on these assessments of student learning has resulted in teachers "teaching to the test" (Southerland, Abrams, Hutner, 2008). Saka, Southerland, & Brooks (2009) investigated how new science teachers' enactment of science education reform-based practices was impacted by the school community they were inducted into. The study compared the experiences of two reform-minded science teachers as they began their teaching careers in two different schools. One of the teachers, Nathan, who began his teaching career in a school that historically underperformed on state standardized testing found it difficult to teach in reform-based ways. The culture of his school that prioritized raising test scores, overtime led this teacher to question the goals and practices of science education reform he once agreed with, and restrict his practices to align more with the school.

Achinstein, Ogawa, & Speigman (2004) also argue that state policy environments impact the types of instruction teachers use in their classrooms. The authors conducted detailed case studies of two upper elementary teachers, Liz and Sam, to examine their use of literacy practices in two different districts located 30 miles from one another in the same state. For comparative purposes the researchers also studied another teacher from each school as well as another teacher from a different school, but from the same district for a total of six teachers. Extensive interviews were conducted with these sample teachers, their mentors, colleagues, building administrators, district superintendents, literacy coaches, and directors of curriculum and instruction. Observations of practice were videotaped and scored for level of discourse in literacy practices. State documents of accountability and instruction were also reviewed to provide a background of the policy environment. Data analysis provided evidence that Liz and

Sam used different instructional practices that replicated their schools' and districts' curricular and instructional decisions. Liz's instruction emphasized repetition and routine, was more direct in nature, and focused on standards. Sam was more student-centered in his approach and used a variety of teaching methods to teach the standards. The practices of the other teachers in these two districts mirrored that of Liz and Sam.

The researchers found that the two districts varied in how they recruited teachers, the types of professional development offered to teachers, and the way they responded to state accountability and instructional policies. The interaction of these differences was found to both directly and indirectly affect the socialization of both teachers. "Liz and Sam are coming to learn what it means to be a teacher in two different cultures that (a) provide different resources for students and teachers, (b) differ in regard to the quality and quantity of professional learning opportunities, (c) have different expectations for students and teachers, and (d) promote different instructional practices (p. 580). Liz's district possessed less district capital, subscribed to a more rigid state created literacy curriculum, and underperformed on state accountability assessments. Sam's district possessed enough district capital to reject the state promoted literacy curriculum, favoring their own approaches to literacy, created opportunities for professional development in which teachers co-created instructional approaches, and performed well on standardized measures of student achievement. The authors claim that the accountability measures of the state policies that are more burdensome for lower achieving schools with higher percentages of students from low-income and minority backgrounds "may have produced an unintended consequence: the creation of a class of schools and districts with pedagogical approaches emphasizing routines and direct instruction that affect the socialization of new teachers, contributing to the formation of two teacher tracks" (p. 584). The authors describe these tracks

as “distinguished by the nature of inputs, with teachers experiencing different levels of resources, learning opportunities, instructional control, and expectations that result in their beliefs and practices being aligned with lower or higher status” (p. 592). This tracking of teachers may in fact “reproduce inequities” that these reforms seek to alleviate, and thus contributing to the achievement gap across race and social class.

### **Conceptual Model of Teacher Socialization: Three Spheres of Influence**

In order to understand the variation observed in the enactment of reform-based practices by secondary science teachers as well as to identify and explain the factors that are most influential in determining the kinds of practices teachers use, it is important to look across the teacher-learning continuum at the three different spheres of socialization forces. Teachers’ backgrounds, both personal and professional, shape the primary socialization experiences for teachers. Their personal histories frame their earliest socialization into teaching and impact their initial beliefs about teaching and learning. Teachers’ professional preparation provides socialization into the pedagogy of reform-based science teaching, providing the theory, and guided practice for enacting this type of instruction. The local context in which teachers start their careers as professional teachers continues to shape teacher socialization. Teachers can experience tension as they make the transition from student to teacher. The culture of the school and instructional climate can influence the practices that teachers enact. The way in which key players in the school and district respond to state education policies also exerts influence on the socialization of teachers. The state policy environment, which dictates standards and accountability measures, shape the policies of districts regarding curriculum, assessment, and professional learning opportunities for teachers. Ultimately this affects socialization into teaching and the resulting practices they implement in their instruction.

Using teacher socialization as a theoretical framework, this mixed-methods study analyzed both the separate and combined contribution of each sphere of influence of teacher socialization as well as the way in which these socialization forces interact to explicate the variance found in the enactment of reform-based practices of secondary science teachers. The first phase of the study was conceptualized to investigate the relationship between the level of reform-based practices employed in the classroom with a combination of predictor variables: teacher background variables (personal and professional), beliefs about reform-based science teaching and feelings of preparedness to teach science, school contextual variables and professional learning opportunities and instructional influences from the policy environment (Figure 2). Information from this first phase was explored further in a second qualitative phase. In the second phase, multiple case study methods were used to further explore aspects of the three spheres of teacher socialization deemed to be significant in explaining teacher practice.



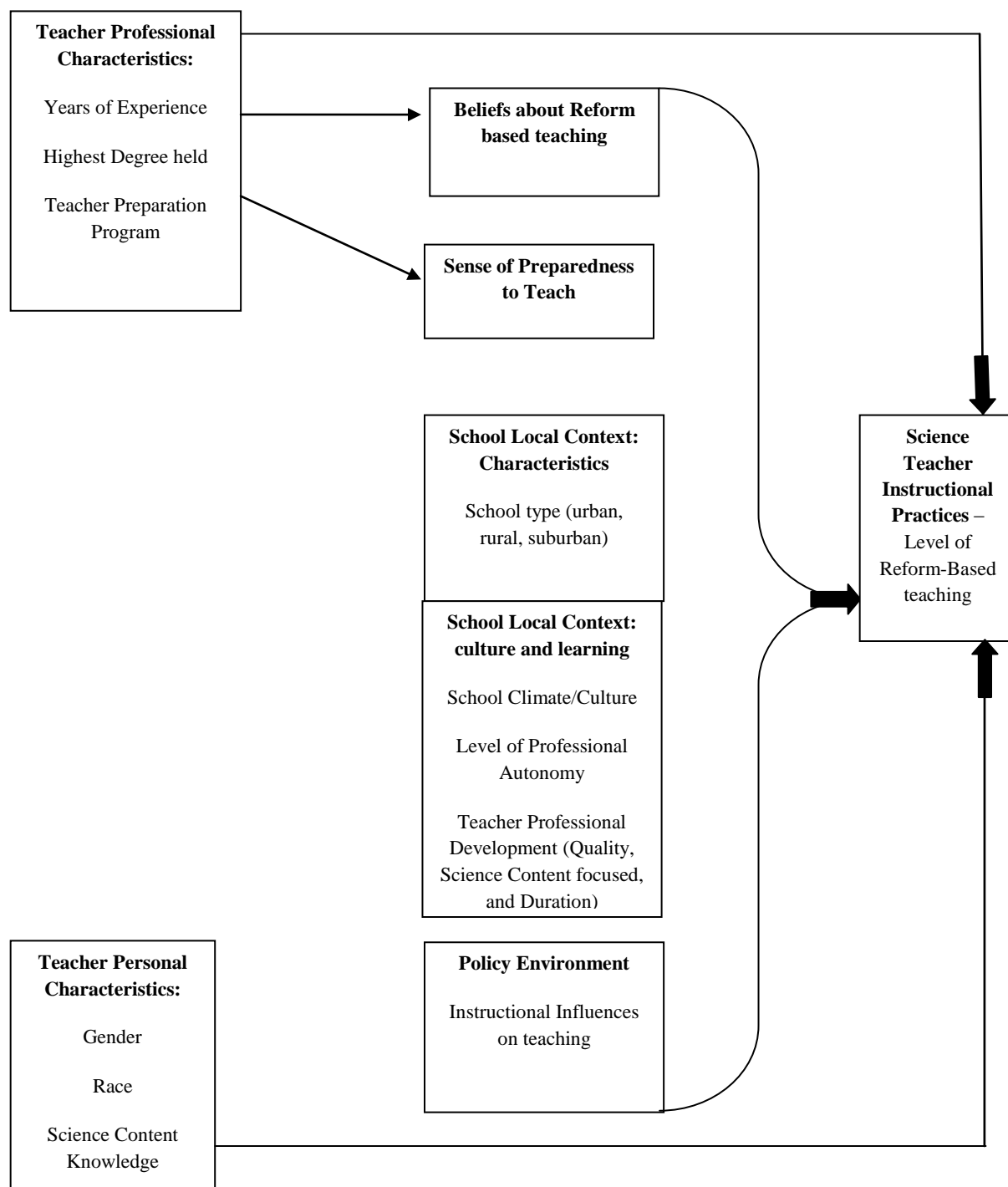


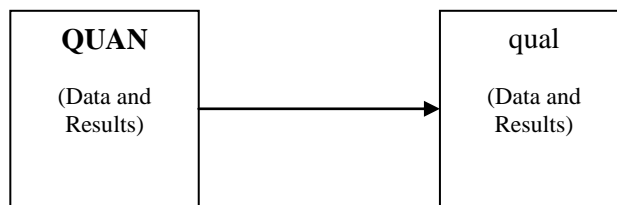
Figure 2. Conceptual Model

### CHAPTER THREE: METHODOLOGY

The purpose of this mixed-methods study was to determine the relative influence of secondary science teachers' characteristics, backgrounds, and experiences across their teacher development to explain the range of teaching practices exhibited by graduates from three reform-oriented teacher preparation programs. This chapter describes the design and methods used in this study. The chapter begins with an overview of the research design and questions. Next is a description of the source of data for this study. Following the description of the data is an explanation of methods and analysis plan for each phase of this mixed-methods study.

#### Research Design

This study utilized teacher socialization as a guiding theoretical framework in the identification of important variables as well as the analysis. The mixed-method research design implemented in this study was a two-phase, sequential explanatory mixed method design (see figure 3). In a sequential explanatory design the study occurs in two phases. In the first phase, quantitative data is collected and analyzed, and is followed by a qualitative phase to help explain/elaborate the results from the quantitative phase (Creswell, 2008; Ivankova, Creswell, & Stick, 2006). The strength of such a design “using both quantitative and qualitative methods, in combination, provides a better understanding of the research problem and questions than either method by itself” (Creswell, 2008, p. 552).



*Figure 3.* Sequential Explanatory Mixed-Methods Design (Creswell, 2008)

Ivankova, Creswell, & Stick (2006) note that when employing a sequential explanatory design it is necessary to detail the priority and weight of both the quantitative and qualitative research phases, the sequence of the phases, and the stages of how the phases will be implemented. The authors advise providing a visual representation of the procedures used for a mixed-methods study. The following description provides a summary of these design components and is graphically represented in figure 4.

As is typical with most sequential explanatory research designs, priority was given to the quantitative first phase of this study, which investigated the correlates of secondary science teachers' use of reform-based teaching practices (Ivankova, Creswell, & Stick, 2006). These factors, previously identified in the literature review as being important to the socialization of teachers and their instructional practices, include teachers' personal and professional background characteristics, beliefs about reform-based science teaching, feelings of preparedness to teach science, school contextual characteristics, school culture and climate of professional learning, and influences of the policy environment. Phase one of the study used hierarchical multiple regression analysis to examine the separate as well as the combined influence of these factors on teacher's use of reform-based teaching practices. The goal of this analysis was to determine the relative strength of each as a socializing force on the kinds of instructional practices teachers implement. Information from this first phase was then used in a second qualitative phase. In the second phase, multiple case study methods were used to further explore aspects related to teachers' use of reform-based teaching practices. This second phase helped to better understand or "refine" the quantitative results by following up with analysis from more detailed cases (Creswell, 2008, p. 560). The quantitative analysis guided the selection of the phase two case study sample, focusing on teachers' who fell at the low and high ends of the range of

implementation of reform-based teaching practices as well as those who were at the mean. This secondary qualitative data analysis served to enhance the understanding of the complexities of learning to engage in reform-based teaching practice for those who employ these practices often and for those who seldom implement them. The research questions of this study were:

Phase 1:

1) How much variation in secondary science teachers' use of reform-based instructional practices is accounted for by a set of personal background variables (gender, race, and level of science content knowledge), a set of professional background variables (teacher preparation program, type of certification degree, and years of experience teaching), a set of efficacy/beliefs variables (sense of preparedness and beliefs about reform-based science teaching), a set of school contextual variables (school context, school climate/culture, and professional development opportunities), and a policy related variable (policy related instructional influences)?

2) Do school contextual variables and policy influences explain additional variation in teacher practices after accounting for the variation in practice due to personal and professional background variables and efficacy/beliefs variables?

Phase 2:

How do the factors identified in the model related to personal backgrounds, local school context, and state policy environment contribute to explaining the differences in levels of reform-based science teaching exhibited by graduates from three reform-oriented teacher preparation programs?

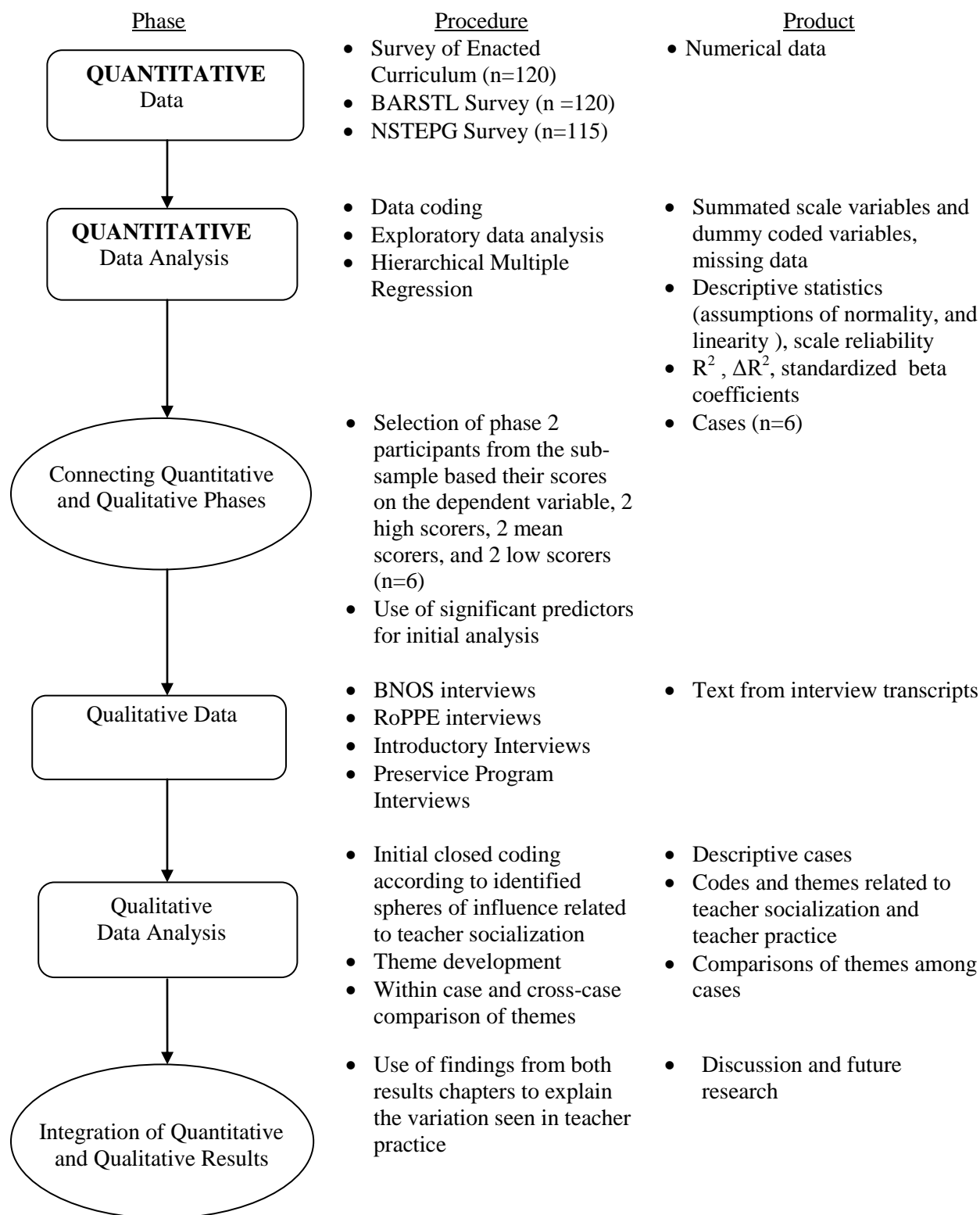


Figure 4. Visual Model for Sequential Explanatory Study Design Procedures (based on model by Ivankova, Creswell, & Stick, 2006)

### **Rationale for a Mixed-methods Design**

A research design that seeks to utilize a mixed-methodology is generally an “approach to knowledge (theory and practice) that attempts to consider multiple viewpoints, perspectives, positions, and standpoints” (Johnson, Onwuegbuzie, & Turner, 2007, p. 113). In this type of research design, the merger of elements from both quantitative and qualitative research is desired for the purpose of “breadth and depth of understanding and corroboration” (Johnson, Onwuegbuzie, & Turner, 2007, p. 123). The quantitative part of a study provides a general understanding of the problem, while the qualitative portion “refines and explains” the quantitative results by looking in-depth at the participants views (Ivankova, Creswell, & Stick, 2006). Scholars have argued that due to the strengths of the combination of these two research methodologies, mixed-methods research should be “widely recognized in education” research as the “third major research paradigm” (Johnson & Onwuegbuzie, 2004, p. 23).

There are several reasons why researchers seek to employ a mixed-methods approach despite the increase in time and labor resulting from the collection and analysis of both quantitative and qualitative data. In the field of social science and education research, the problems of interest are complicated, and thus challenge researchers who wish to move beyond just describing the problem to better understand the causes and mechanisms of a problem as well as the interworking of the component parts. In such research pursuits, a single quantitative or qualitative approach is often inadequate to fully address the research problem (Creswell, 2009; Ivankova, Creswell, & Stick, 2006). However, the combination of both kinds of data collection can lead to stronger analysis and a more holistic understanding of the issue (Creswell, 2009; Denscombe, 2008; Ivankova, Creswell, & Stick, 2006). Collins, Onwuegbuzie, & Sutton (2006)

refer to this strength of mixed-methods research as a “significance enhancement” which can “facilitate the thickness and richness of data by utilizing two methods of data collection” (p. 92). These authors contend that the mixing of multiple sources enhances the interpretation of data. Overall, strong analysis provides even stronger evidence for conclusions and produces “more complete knowledge needed to inform theory and practice” (Johnson & Onwuegbuzie, 2004, p. 21).

In this study, the collection and analysis of survey data from a larger sample of secondary science teachers provided broad numeric trends to help understand what factors contribute to the variation that exists in the practices of secondary science teachers. While this data can aid the identification of significant factors related to the use of reform-based teaching practices as well as allow for greater generalizability for researchers and policy makers, this quantitative data cannot offer explanations as to how or why these variables affect practice. As a result of the complex nature of how and why teachers are socialized to implement instructional practices, deeper understanding requires additional data collection and analysis. Qualitative data analysis allows the researcher to move beyond answering questions about the relationship between variables, and toward addressing how and why questions (Collins, Onwuegbuzie, & Sutton, 2006). The second qualitative phase of this study provided in-depth study of teachers’ views regarding influences to their practice.

### **Description of Data Source**

This mixed-methods study draws on an extant data set collected from The IMPACT Project (Investigating the Meaningfulness of Preservice Programs Across the Continuum of Teaching in Science Education, NSF TPC Grant # 0455819). This five-year study (2005 – 2010) was a multi-university, collaborative research study involving Syracuse University, the

University of Iowa, and North Carolina State University. The purposes of the IMMPACT Project were: 1) to better understand secondary science teachers' learning of content and pedagogy over time as a result of key interventions within these preservice science teacher preparation programs; 2) to assess the subsequent impact of this learning on their classroom teaching and 7-12 grade student outcomes; and 3) to determine what factors significantly influence secondary science teachers' beliefs and classroom practices following graduation from these preservice preparation programs. The study was specifically targeted at investigating the longitudinal impact of preservice science teacher education program learning experiences on middle and secondary science teachers and their students (grades 7-12) across critical stages of the teacher continuum including: 1) upon entry into science teacher education; 2) during the candidacy stage of science teacher education programs including associated field experiences; 3) during the early induction years as a new science teacher (years 1-4); and 4) during the post-induction stage of science teaching (years 5+). An emphasis was placed on examining how formal and informal learning experiences in science teacher education—in both pedagogy courses and subject matter courses—affect science teachers' knowledge, epistemological beliefs, and classroom practices. The IMPPACT project research sought to examine the unique developmental process that occurs during preservice, induction, and post-induction years related to teacher behaviors and beliefs, as well as how skills, beliefs, and knowledge intersect.

Interdisciplinary research teams consisting of science teacher educators, scientists, and doctoral research associates at Syracuse University (SU), the University of Iowa (UI), and North Carolina State University (NCSU) were active partners in the IMPPACT study. In addition, a panel of experts comprised of nationally renowned scholars, researchers, 7-12 practitioners, and administrators with expertise in teacher education, professional development, large-scale



qualitative and quantitative research design, cognitive sciences, and the natural sciences provided ongoing technical assistance to the project researchers.

These three universities were chosen as research sites for a number of reasons. First, the project investigators chose to focus the study on large, doctoral-granting institutions that are similar in size, characteristics and preservice program features, yet located in different geographic regions of the country. The research teams were able to investigate how program interventions impact science teacher development over time in the broadest range of secondary school settings possible. Each of these preservice programs had an undergraduate and graduate certification degree option, required extensive science content coursework, featured multiple science methods courses, required field placements at multiple grade levels in socioeconomically and culturally diverse schools, offered specialized courses in technology, assessment or science-technology-society applications, and had a nature of science component within the overall program. The rich array of program features in common across these three institutions allowed for strategic within and cross-site comparisons to be made related to each research question. While these program features are common to all programs, there are also differences with regards to the amount/implementation of program interventions. These differences allow for a strategic comparison and evaluation of teacher preparation as a predictor (see figure 5).

The IMPPACT study used a longitudinal design involving a collection of quantitative and qualitative data to better understand the overall impact of these preservice programs. The quantitative measures in the project provided information concerning patterns and trends in the pools of data, while the qualitative measures provided data for a careful and detailed analysis of individual teacher, student, and program outcomes. Multiple, repeated surveys, in-depth

interviews, classroom and field observations, artifact collection, and samples of both teacher and student work provide a rich data source to systematically and thoroughly answer each of the research questions. All data collection and analysis protocols were uniformly implemented across the three university research sites.

University	Multiple Methods	Purposeful Cohort	Placement Hours	Reflective Practices				NOS	Educational Technology	Applications of Science	STS
				Rationale Paper	Action Research	Video Reflection	Micro-teaching				
NCSU	Two 3-credit hour courses	No	342.5	No	No	Yes	Yes	Yes	One 3-credit hour course	No	No
SU	Two 3-credit hour courses	Yes	540	Yes-in 1 course	Yes	Yes	Yes	One 3-credit hour course	No	No	No
UI	Three 3-credit hour courses	Yes	720	Yes-in 3 courses	Yes	Yes	Yes	Two 3-credit hour courses	One 3-credit hour course	Two 3-credit hour courses	Yes

*Figure 5. List of Interventions by University (Tillotson & Young, 2013)*

The IMPACT project investigators randomly sampled cohorts of preservice and inservice science teachers at each university across key stages of the teacher continuum and tracked them for a period of four years. In Year one (2005-2006), the project researchers conducted a pilot study of all the instruments and data collection protocols using one teacher in

each of the four stages of the continuum at each university for a total of 12 participants. In year two, the sample increased to a minimum of ten teachers in each stage of the continuum at each site (40 teachers per university x 3 universities = minimum of 120 total science teachers in the overall study). The IMPPACT researchers did oversample to account for possible attrition, with a final sample of n~150 teachers. The specific stages of the continuum include: 1) entry into science teacher education; 2) the candidacy stage of science teacher education programs including the associated field experiences; 3) the early induction years as a new science teacher (years 1-4); and 4) the post-induction stage of teaching (years 5+). A smaller sub-sample of teachers at each site (10/site) was selected for in-depth analysis and more extensive data collection. All the data for the IMPPACT project have been de-identified.

This current study utilized both quantitative and qualitative data from the IMPPACT project for secondary analysis to answer the research questions. Data for this study was collected from the broader sample survey information as well as from the smaller sub-sample of “in-depth” teachers’ interviews throughout the course of the project. More specifically the first phase of the study drew primarily on data from three surveys that were administered to the entire sample of teachers in the IMPPACT study, the *Beliefs about Reformed Science Teaching and Learning* (BARSTL), the *Survey of Enacted Curriculum* (SEC), and the *National Survey of Teacher Education Program Graduates* (NSTEPG). The qualitative data for the second phase of the study were drawn from transcripts of interviews conducted with the in-depth teachers of the IMPPACT sub-sample. These interviews include: the IMPPACT Introductory Interview, the Preservice Program Interview, Teachers Beliefs and Nature of Science (BNOS), and the Reflections on Preservice Program Experiences (RoPPE). These instruments are discussed in the following sections related to the phase of the study in which the data was gathered and analyzed.

## **Phase One: Quantitative Study**

### **Design and Instrumentation**

The first phase of this study was quantitative in nature. This phase of the study used data from the BARSTL, SEC, and NSTEPG surveys, and IMPPACT Project master database to gather data necessary to build a regression model to assess the relationships between a set of independent variables and secondary science teachers' level of reform-based instructional practice.

The IMPPACT Project created a master database to track all the study participants and created an identification system to link each participant's data because all data from the project were de-identified. Each participant was given a unique code (example code UI 1-1) relating to their university of teacher preparation, UI, SU, or NCSU, their cohort/experience level (1 - 4), and the final number representing a unique number as a member of that cohort. All survey data and interview data were labeled with the participants' unique codes, allowing for the gathering of the multiple sources of data used in this study. In addition to a unique code, all IMPPACT participants were assigned a pseudonym to be used in communication of research findings. All names used in this current study are the IMPPACT assigned pseudonyms.

The BARSTL survey instrument (Appendix A) is a 32 item self report measure of science teachers' beliefs about reform-based science teaching and learning developed by Sampson and Benton (2006). According to Sampson and Benton, "the design of the BARSTL is based on the assumption that teachers with different pedagogical content beliefs about the teaching and learning of science will respond to statements describing either reformed or traditional perspectives of science teaching and learning differently" (p. 9). Respondents are asked to rate how much they agree with each of the 32 statements. The BARSTL uses a four-point scale to

quantify the degree in which the teacher agrees with the statement about teaching or learning (1=strongly disagree, 2=disagree, 3=agree, and 4=strongly agree). The total possible scores range from 32 to 128 points with higher scores reflecting pedagogical content beliefs about the teaching and learning of science that are more consistent with the current reform movement in science education. The authors conducted an exploratory factor analysis with the instrument showing four factors emerging. The four factors together account for 39.5% of the item variance. According to the authors, two internal consistency estimates of reliability were computed for the BARSTL: a split half coefficient expressed as a Spearman-Brown corrected correlation and coefficient alpha. They find that the BARSTL is internally consistent reporting the value of the split-half coefficient was 0.80 and the value of coefficient alpha was 0.77. The authors state, “in order to ensure content validity, the items that make up the BARSTL have been evaluated by a panel of experts to be representative with regard to the four dimensions (how people learn, lesson design and implementation, characteristics of teachers and the learning environment, and the science curriculum) of pedagogical content beliefs” (p. 22).

The BARSTL survey instrument was converted to an electronic survey, which was administered via Zoomerang.com, a web-based survey administration site. The BARSTL was administered to all cohorts of teachers at all three sites (all participants) during the month of November for the three consecutive academic years of data collection from 2006-2007 through 2008-2009. The IMPACT Project Director sent an email with the URL for the survey with an email invitation for participants to take the survey. Reminder emails were sent to participants who did not complete the survey after the director’s first invitation. The response rates were 91% in the first year, 83% in the second year, and 67% in the third year. After all survey data was collected, the data was downloaded from Zoomerang and coded. Sampson and Benton

(2006) provided guidelines for the coding of the data, specifically for half of the questions to be reverse coded. After this coding was done, data from the survey were entered into a statistical software package, Statistical Package for Social Sciences (SPSS). A separate file for each year of BARSTL data collection was created. A composite score for each year for each participant was created.

The SEC (Appendix B) is the product of a two-year joint venture between the Council of Chief State School Officers (CCSSO's) State Education Assessment Center, researchers from the University of Wisconsin-Madison, and state education specialists in science, mathematics, and assessment (Blank, Porter & Smithson, 2001). It is a comprehensive survey instrument measuring teachers' self reported science classroom instructional practices. The intent of the SEC is to help answer questions about the differences in instructional practices exhibited by teachers in different classrooms, schools, and even states. According to Blank, Porter, and Smithson (2001), "the SEC project was designed to address broad questions about standards-based reform by testing a survey approach to analyzing the enacted curriculum in math and science. They defined "enacted curriculum" as the actual subject content and instructional practices experienced by students in classrooms" (p. i). The underlying concepts of the survey instrument are based on state and national content standards and prior research on classroom instructional practices. The survey provides a "snap shot" of teachers' classroom instructional practices, evidence of policy influences on instruction, reports of how their instructional practices relate to their teacher preparation, the influence of the school environment/culture, and levels of professional development. The survey measuring instructional practices in science contains 152 questions and includes multiple rating scales pertaining to instruction, professional development, instructional influences, school culture, and instructional preparation. The survey

also includes a demographic section detailing questions about the student population of the classroom as well as teacher demographic information such as number of years teaching, highest degree held, and number of content courses taken in science.

The IMPPACT study created an electronic version of the SEC survey and administered it via Zoomerang.com, a web-based survey administration site, during all three years of data collection. Due to the nature of the questions relating to classroom instructional practices, the survey was only administered to teachers who had graduated from their teacher preparation programs and were actively teaching during the time of each survey administration. It was administered to all participants in cohorts three and four in the month of January every year during IMPPACT Project data collection. For cohort two, the SEC was administered in January during year two and three of IMPPACT Project data collection. For cohort one, the SEC was only administered in January during data collection year three. As with the BARSTL survey, the IMPPACT Project Director sent an email with the URL for the survey with an email invitation for participants to take the survey. Reminder emails were sent to participants who did not complete the survey after the director's first invitation. In the 2006-2007 academic years, the SEC was collected from 66 participants representing cohorts three and four. During the 2007-2008 academic year, 94 participants completed the survey, representing cohorts two -four. In the final year of data collection, 2008 – 2009, 93 participants completed the SEC out of all four cohorts. After the data was collected, it was downloaded from Zoomerang and entered into a statistical software package, SPSS. A separate file was created for each year of SEC data collection.

The IMPPACT Project used a modified version of the NSTEPG (Appendix C) developed by Loadman, Freeman, Brookhart, Rahman, & McCague, (1999). This survey includes

information on teacher demographics and employment, their career satisfaction and professional development, as well as an additional section added by the IMPACT program gathering ratings of the quality of preservice program components. The IMPACT study created an electronic version of the NSTEPG survey and administered it via Zoomerang.com. Due to the nature of the questions relating to demographics of school district employer, classroom instructional practices and quality of the teacher preservice program, the survey was only administered to teachers who had graduated from their teacher preparation programs and were actively teaching during the time of each survey administration. It was administered to all participants in cohorts three and four in September in the first year of data collection because they were the only teachers to have completed their teacher preparation at that point in the study. For cohort two, the NSTEPG was administered in September during the second year of data collection, as this was after they had completed their preparation program. The year three of data collection, the NSTEPG was administered to cohort one in September to capture their opinions post teacher preparation. By this last year of data collection the NSTEPG was administered to all the participants in the study sample. As with the other two surveys, the IMPACT Project Director sent an email with the URL for the survey with an email invitation for participants to take the survey. Reminder emails were sent to participants who did not complete the survey after the director's first invitation. Throughout the three years of data collection 148 secondary science teacher graduates of the three teacher preparation programs completed the NSTEPG survey. After the data was collected, it was downloaded from Zoomerang and entered into a statistical software package, SPSS. A file was created for the NSTEPG across all study sites.

I used the SPSS files from the IMPACT database from all three years of the project to identify a sample of teachers who took the BARSTL, SEC, and NSTEPG surveys, post



graduation from their preservice preparation and while teaching. These three instruments were used to collect the multiple measures detailed below for each participant in this study. Using SPSS version 20, I created a separate file to merge the data from these three surveys to create the variables used in this study.

## **Sample**

Of the broader IMPPACT Project sample a total of 120 teachers were identified that took both the SEC survey instrument and the BARSTL survey instrument while actively teaching. These teachers served as the sample for phase one of this study. The BARSTL survey was administered over the course of three years, and the SEC was only administered when teachers were post-graduation. The IMPPACT sample contained responses to these survey instruments from multiple years; however, for this current study, each participant's responses to both surveys were taken from the same year of data collection to ensure their self-reported beliefs and measures on the SEC were reported during the same school year. Five of the teachers from this sample did not take the NSTEPG survey. They were included in the analysis, and the missing cases for the two variables operationalized using the NSTEPG are reported in chapter four.

## **Variables**

### **Independent variables**

The following is a description of how each of the independent variables used in this study were operationalized. Table 6 provides a summary of these variables and their measures.

***Teacher Gender-*** Teacher gender was operationalized using question 141 on the SEC survey instrument in which teachers were asked to respond 0 if they are female and 1 if they are male.

***Teacher Race*** – Teacher race was operationalized using question 142 on the SEC. Teachers were asked to indicate all that apply from the following choices: 1) American Indian or Alaskan Native, 2) Asian, 3) Black or African American, 4) Hispanic or Latino, 5) Native Hawaiian or other Pacific Islander, 6) White. There were five missing cases for question 142 on the SEC. These five missing cases were cross referenced against the NSTEPG survey, and all five were identified on this survey which asks teachers to identify their ethnic background in question one given the following choices: (1) American Indian or Alaskan (2) Asian or Pacific Islander (3) Black, non-Hispanic (4) Hispanic (5) White, non-Hispanic (6) Other. 94.2% of the sample reported white as their race, with the remaining 5.8% reporting a non-white race. Due to low response rates or low representation for non-white race choices (2.5% reported Asian, 2.5% reported Black, .8% reported Native Hawaiian or Pacific Islander, 0% reported Hispanic or Latino, and 0% reported American Indian or Alaskan Native) this scale was collapsed to teachers' response as white or non-white (Babbie, 1990).

***Highest degree earned***– The highest degree that has been earned was operationalized using question 145 from the SEC survey instrument. Teachers were asked to respond to this question by choosing 0= does not apply, 1= BA or BS, 2= MA or MS, 3= Multiple MA or MS, 4= Ph.D. or Ed.D. or 5= Other. Due to the low variability of participants selecting 3, 4, or 5, for the purposes of this study the scale was collapsed to indicate if a teacher has a Bachelors degree or a Masters or higher degree.

***Science content knowledge*** – A Teacher's level of science content knowledge was operationalized using teachers' self reported number of science courses taken in questions 149 – 151 on the SEC survey instrument. Teachers are asked to report how many Biology/Life Science (question 149), Physics/Chemistry, Physical Science (question 150), and

Geology/Astronomy/Earth Science (question 151) courses were taken at either the undergraduate or graduate level. For each question, teachers are asked to respond to a scale of 0 – 9 with each choice representing a range of number of courses taken: 0= 0, 1 = 1- 2, 2 = 3 - 4, 3= 5 - 6, 4= 7- 8, 5= 9 - 10, 6= 11-12, 7=13 - 14, 8 = 15 - 16, 9= 17+. To gain a sum score representative of the total science courses taken an overall average number of classes score was determined using the teachers' answers to these three questions to represent the amount of science content knowledge. To do this, I first converted a teacher's response for each question (which was a range of classes) to an average score. The data for each of the three questions was then recoded to reflect this: 0=0 courses, 1= 1.5 courses, 2=3.5 courses, 3=5.5 courses, 4=7.5 courses, 5=9.5 courses, 6=11.5 courses, 7=13.5 courses, 8=15.5 courses, 9=17 courses. Then the teacher's average responses for each of the three questions were added together for a final average sum of science content courses.

***University of preparation*** - The university of preparation refers to the university in which teachers graduated from for their science teacher preparation. The three reform-oriented Universities that this study draws participants from are University of Iowa (UI), Syracuse University (SU), and North Carolina State University (NCSU). At the time teachers were selected to be a part of the IMPPACT study they were given a unique identifying code as previously discussed. The first number of the code refers to the university the teacher graduated from. This code allowed for all data collected from the IMPPACT sample to be identified by the university of preparation. In all identification codes in the IMPPACT database, all participants with the first code of one are graduates of SU, codes beginning with the number two are graduates of UI, and codes beginning with the number three are graduates of NCSU.

***Years of experience-*** The number of years of teaching experience for teachers in this sample was operationalized using Question 143 from the SEC survey instrument. Teachers were asked to respond to a scale indicating how many years they have been teaching prior to the year taking the survey. There were six possible choices in the scale for teachers to respond to: 0= less than 1 year, 1= 1 - 2 years, 2 = 3 - 5 years, 3 = 6 - 8 years, 4 = 9 - 11 years, 5 = 12 -15 years, and 6 = more than 15 years. For the purposes of this study, the categories on the scale were collapsed to 0 = less than 1 year, 1 = 1-2 years, 2= 3-5 years, 3= 6-8 years, 4= 9 + years teaching experience.

***Beliefs about reform based science teaching and learning–*** Teachers' beliefs about science teaching and learning were operationalized using the BARSTL survey instrument. A sum score for the 32 item beliefs inventory was created to represent the teachers' beliefs. Total possible scores ranged from 32 – 128. This scale was then mean centered in order for the scale to contain a true zero point (Bryk & Raudenbush, 1992). The overall mean value of the beliefs variable (94.32) was subtracted from each individual's score for this variable. After centering this variable, the range was -15.32 to 21.68.

***Sense of preparedness to teach science –*** The teachers' sense of preparedness to teach science was operationalized using the SEC survey instrument scale, Teacher Preparedness for using Innovative Teaching Strategies. This scale was created from six items on the SEC intended to measure this construct (see table 1). Teachers were asked to respond to a four point Likert scale indicating how well they were prepared for the instructional strategies with 0 = not well prepared and 3 = very well prepared. A total sum score for each participant was generated to measure this variable. Reliability analysis was computed and indicated that the items form a scale that has reasonable internal consistency reliability. Reliability statistics for all scales used in the phase one analysis are presented later in this chapter.

Table 1  
*Sense of Preparedness to Teach Science Scale*

Statement	SEC Item
Teach Science at your assigned level	Q 83
Integrate science with other subjects	Q 84
Provide science instruction that meets science Content standards (district, state, or national)	Q 85
Use a variety of assessment strategies (including objective and open-ended formats)	Q 86
Manage a class of students who are using hands-on or laboratory activities	Q 87
Take into account students' prior conceptions about natural phenomena when planning	Q 88
<b>Number of items in scale</b>	<b>6</b>
<b>Scale Range (Likert 0 – 3)</b>	<b>0- 18</b>

*School setting type* – The type of school district that a teacher worked in was operationalized using the NSTEPG survey instrument in which teachers were asked in question nine to indicate the setting of their school building. Teachers were asked to respond to the following choices 1) inner-city, 2) urban, 3) suburban, 4) town, and 5) small town/rural. For the purposes of this study teachers were identified as either working in a rural (collapsing town and small town/rural), suburban, or an urban school district (collapsing inner-city and urban). There were five missing cases for this variable.

*Level of Professional Autonomy*- The level of professional autonomy experienced by teachers was operationalized using question 35 from the NSTEPG survey instrument. Teachers were asked to indicate their level of professional autonomy and decision making authority on a seven point Likert scale with 1 = very negative and 7=very positive.

*Instructional influences on teaching scale* – Teachers perceptions regarding the degree to which district, state, and national policies influence their teaching was operationalized using a scale

created from the SEC survey instrument. This scale was created using seven items, questions 71, 72, 74, 75, 76, and 81, 82 (see table 2). Teachers were asked to respond to these questions using a six point Likert scale indicating the degree to which each item had a negative or positive influence on their teaching with 0= not applicable, 1= strong negative influence and 5= strong positive influence. A total sum score for each participant was generated to measure this variable. Reliability analysis was computed and indicated that the items form a scale that has moderate internal consistency reliability. Reliability statistics for all scales used in the phase one analysis are presented later in this chapter.

Table 2  
*Policy Related Instructional Influences Scale*

Statement	SEC Item
Your state's curriculum framework or content standards	Q 71
Your district's curriculum framework or guidelines	Q 72
State tests or results	Q 74
District tests/results	Q 75
National science education standards	Q 76
Parents/Community	Q 81
Preparation of students for the next grade level	Q 82
<b>Number of items in scale</b>	<b>7</b>
<b>Scale Range (0 – 5)</b>	<b>0 - 35</b>

*School Climate/Culture scale* – Teachers' perceptions of their school climate/culture was operationalized using a scale created from SEC survey instrument. This scale was created using eight items, questions 95 – 102 (see table 3). Teachers were asked to respond to these questions using a five point Likert scale indicating how collegial their peers and administrators are, the trust that exists in the school, and feelings of support with 0 = strongly disagree that these conditions exist and 4 = strongly agree that these conditions exist in their school. Question 96 was reversed coded to reflect the trend in the other questions. A total sum score for each participant was generated to measure this variable. Reliability analysis was computed and

indicated that the items form a scale that has reasonable internal consistency reliability.

Reliability statistics for all scales used in the phase one analysis are presented later in this chapter.

Table 3  
*School Culture and Climate Scale*

Statement	SEC Item
I am supported by colleagues to try out new ideas	Q 95
I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning science	Q 96*
Science teachers in this school regularly observe each other teaching classes	Q 97
Science teachers in this school trust each other	Q 98
It's OK in this school to discuss feelings, worries, and frustrations with other science teachers.	Q 99
Science teachers respect other teachers who take the lead in school improvement efforts	Q 100
It's OK in this school to discuss feelings, worries, and frustrations with the principal	Q 101
The principal takes personal interest in the professional development of the teachers	Q102
<b>Number of items in scale</b>	<b>8</b>
<b>Scale Range (Likert 0- 4)</b>	<b>0- 32</b>

Note \* item reverse coded in scale to fit the trend in responses

***Professional Development scales*** – The nature of the professional development opportunities available to teachers in this study were operationalized by creating three separate scales from the SEC survey instrument measuring three different aspects of teachers reported professional development activities. The first variable, amount or the duration of professional development, was measured using SEC survey question 103 which asked teachers to report how many hours, since their certification program, have they participated in workshops or in-service training related to science or science education on a scale of 0 – 5, with 0= N/A, 1= 1-6 hours, 2= 7-15

hours, 3= 16 – 35 hours, 4= 36 – 60 hours, and 5 = 61 + hours. The second aspect measured the quality of their professional development (13 items, SEC survey questions 113-125) in which teachers were asked to respond to a four point Likert scale 0=never, 1=rarely, 2= sometimes, and 3= often their professional development engaged them in active learning and was coherent (see table 4). Questions 121 -125 included a N/A response which was collapsed with the never category for analysis in this study. The total sum of these items was used to create a measure of the quality of teachers' professional development experiences.

Table 4  
*Quality of Professional Development Scale*

Statement	SEC Item
Observed demonstrations of teaching techniques	Q 113
Led group Discussion	Q 114
Developed curricula or lesson plans, which other participants or the activity leader reviewed	Q 115
Reviewed student work or scored assessments	Q 116
Developed assessments or tasks	Q117
Practiced what you learned and received feedback	Q 118
Received coaching or mentoring in the classroom	Q 119
Gave a lecture or presentation to colleagues	Q 120
Designed to support the school-wide improvement plan adopted by your school	Q 121
Consistent with your science department or grade level plan to improve teaching	Q 122
Consistent with your own goals for your professional development	Q 123
Based explicitly on what you had learned in earlier professional development activities	Q 124
Followed up with related activities that built upon what you learned as part of the activity	Q 125
<b>Number of items in scale</b>	<b>13</b>
<b>Scale Range (0 – 3)</b>	<b>0 – 39</b>



The third aspect measured the degree to which professional development was science content specific (11 items, SEC survey questions 130 – 140) in which teachers were asked to respond to a six point Likert scale indicating how often their professional development was science specific with 0=never, 1= once or twice a year, 2= once or twice a term, 3= once or twice a month, 4= once or twice a week, and 5= almost daily (see table 5). The total sum of each of these items was used to create a measure of the science content specific nature of teachers' professional development. Reliability analysis was computed and indicated that the items form a scale that has reasonable internal consistency reliability. Reliability statistics for all scales used in the phase one analysis are presented later in this chapter.

Table 5

*Amount of Science Content Specific Professional Development Scale*

Statement	SEC Item
State science content standards (for example, what they are and how they are used)	Q 130
Alignment of science instruction to curriculum	Q 131
Instructional approaches (for example, use of manipulatives)	Q 132
In-depth study of science or scientific concepts within science (for example, earth science)	Q 133
Study of how children learn particular topics in science	Q 134
Individual differences in student learning	Q 135
Meeting the learning needs of special populations of students (for example, second language learners; students with disabilities)	Q 136
Classroom science assessment (for example, diagnostic approaches, textbook-developed tests, teacher-developed tests)	Q 137
State or District science assessment (for example, preparing assessments, understanding assessments, or interpreting assessments)	Q 138
Interpretation of assessment data for use in science instruction	Q 139
Technology to support student learning in science	Q 140
<b>Number of items in scale</b>	<b>11</b>
<b>Scale Range (0 – 3)</b>	<b>0 - 33</b>

Table 6  
*Description of Independent Variable*

Variable	Type	Measure	Code/Range of Responses
Teacher Gender	Dichotomous	SEC survey question 141	Female = 0, Male = 1
Teacher Race	Dichotomous	SEC survey question 142	White = 0 , Non-white = 1
Highest Degree Earned	Dichotomous	SEC survey question 145	Bachelors = 0, Master or higher = 1
Sci. Content Knowledge	Scale	SEC survey questions 49-151	Total avg. # of science courses = 0 - 51
Univ. of Teacher Preparation	Categorical	IMPPACT Database	Reference variable = NCSU Dummy 1= SU Dummy 2 = UI
Years Teaching Exp.	Scale	SEC survey question 143	0= less than 1 year, 1= 1-2 years, 2= 3-5 years, 3= 6-8 years, 4= 9+ years
BARSTL scores	Scale	BARSTL survey	Centered Total= -15.32 – 21.68
Sense of prep. to teach science	Scale	SEC survey questions 83 - 88	Total sum = 0 – 18
School Setting Type	Categorical	NSTEPG question 9	Reference variable = Rural Dummy 1= Suburban Dummy 2 = Urban
Level of Prof. Autonomy	Scale	NSTEPG question 35	Scale 1 - 7
Instructional Influences scale	Scale	SEC survey questions 71, 72, 74–76, 81, 82	Total sum = 0 - 35
School culture/climate scale	Scale	SEC survey questions 95 - 102	Total sum = 0- 32
Science specific Prof. Development scale	Scale	SEC survey questions 130-140	Total sum = 0 - 33
Quality of Prof. Development Scale	Scale	SEC survey questions 113-120, 121-125	Total sum= 0 - 39
Amount of Prof. Development	Scale	SEC survey question 103	Total hours= 0 - 61+

### **Dependent variable**

*Teachers' use of Reform-based instructional practices*— The teachers' use of reform-based instructional practices was operationalized using a self-report measure from the SEC survey instrument. The reform-based instructional practices scale was created from modified scales identified by Blank, Porter, & Smithson (2001) to measure how congruent teachers' instructional practices are with practices called for in reform documents. Blank, Porter, & Smithson (2001) identified several of these scales to be reliable measures of teachers practice: 1) active learning in science scale  $\alpha = .78$ , 2) scientific thinking  $\alpha = .80$ , and 3) communicating scientific understanding  $\alpha = .72$ . For these three identified scales, teachers were asked to respond to statements about teaching or student tasks/activities, and indicate how often their instruction engages students in the tasks/activities described. Teachers respond on a five point Likert scale ranging from 0 – 4, with 0= none, 1= little, 2= some, 3= moderate, and 4= considerable. This dependent variable scale was composed of 30 items drawn from the three above mentioned SEC scales. Table 7 presents all items used in the creation of this scale. Five of the items (38, 51, 47, 27, and 25) were reverse coded to fit the trend of the rest of the items, a higher response by teachers equating instructional practices that are more reform-based. The total sum of these 30 items was used as the measure of the dependent variable. Reliability analysis was computed and indicated that the items form a scale that has reasonable internal consistency reliability. Reliability statistics for all scales used in the phase one analysis are presented later in this chapter.

Table 7  
*Teachers' Use of Reform-Based Instructional Practices Scale*

Subscale	Statement	SEC Item
A	Collect data or information about science (as a part of homework)	Q 22
A	Read about science in books, magazines, articles ( <b>not</b> textbooks)	Q 26
CST	Write about science in a report/paper on science topics	Q 28
A	Do a laboratory activity, investigation, or experiment	Q 29
A	Watch the teacher demonstrate a scientific phenomenon	Q 30
A	Collect data (other than laboratory activities)	Q 31
A	Work <i>in pairs or small groups</i> (other than laboratory activities)	Q 32
A	Do a science activity with the class outside the classroom or science laboratory (for ex. field trips or research)	Q 33
A	Maintain and reflect on a science portfolio of their own	Q 35
ST	Make educated guesses, predictions, or hypotheses	Q 37
A	Use science equipment or measuring tools	Q 39
A	Collect data (in class)	Q 40
A	Change a variable in an experiment to test a hypothesis	Q 41
CST	Organize and display information in tables or graphs	Q 42
ST	Analyze and interpret science data	Q 43
ST	Design their own investigation or experiment to solve a scientific question	Q 44
ST	Make observations/classifications	Q 45
CST	Talk about ways to solve science problems, such as Investigations	Q 46
CST	Write up results or prepare a presentation from a laboratory activity, investigation, experiment, or research project	Q 48
A	Work on an assignment, report, or project over an extended period of time	Q 49
CST	Have a class discussion about the data	Q 52
ST	Make a prediction based on the data	Q 54
CST	Analyze and interpret the information or data, orally or in writing	Q 55
CST	Make a presentation to the class on the data, analysis, or interpretation	Q 56
CST	Display and Analyze data (using educational technology)	Q 61
A	Follow step-by-step directions	Q 38*
A	Review assignments or prepare for a quiz or test.	Q 51*
A	Complete written assignments from the textbook or workbook	Q 47*
A	Work <i>individually</i> on science assignments	Q 27*
A	Listen to the teacher explain something to the class as a whole about science	Q 25*
<b>Number of items in scale</b>		<b>30</b>
<b>Scale range (0 – 4)</b>		<b>0 - 120</b>

Note \* items were reversed coded in scale to reflect the trend in responses. Subscale A=active learning, CST= communicating scientific thinking, ST= Scientific thinking

## Reliability Analysis

As previously discussed, in preparation for the analysis of the data, six scales, and three subscales were computed from the raw survey data. The reliability of these scales was evaluated using Cronbach's Alpha (Table 8). A scale is considered to have reasonable internal consistency reliability if the reliability coefficient, alpha, is above .7 (Leech et al., 2008). All but one of the computed Cronbach's alphas for the nine scales/subscales was above .7. The scale used as a measure of policy related instructional influences had a Cronbach's alpha of .633. Though this is lower than the recommended level of .7, suggesting it has minimally adequate reliability, Leech et al. (2008) find that it is not uncommon to find alphas reported in the range of .6 -.69 in journal articles. Due to this reliability analysis, all scales were deemed appropriate for the regression analysis; though caution was used in the interpretation of the instructional influences scale measure.

Table 8  
*Reliability Statistics*

Scale	Number of items in scale	Alpha
Reform-based Instructional Activities	30	.911
<i>Active Learning subscale</i>	17	.743
<i>Communicating Scientific Thinking subscale</i>	8	.851
<i>Scientific Thinking subscale</i>	5	.837
Sense of Preparedness to Teach Science	6	.799
Instructional Influences-policy	7	.633
School Culture and Climate	8	.832
Quality of Professional Development	13	.846
Science Content Specific Professional Development	11	.870

## **Sequential Regression Analysis**

The goal of this analysis was to examine the relationships between teachers' use of reform-based teaching practices and sets of predictor variables related to teacher personal and professional backgrounds, and both the local context and the policy environment in which they taught. The phase one analysis utilized SPSS version 20 for the descriptive and the inferential statistics. The data analysis began by visually inspecting all data from the merged IMPACT data files to assess any possible errors in the data merge. During this inspection, it was noted that five missing cases were found with respect to the school setting type and level of professional autonomy. Further discussion of these missing cases is found in chapter four. Then variables were coded and scales were created as described previously in this chapter. Descriptive statistics were calculated to analyze the demographic characteristics of the sample and for the key study variables. Reliability analyses were conducted for all scaled variables, using Cronbach's Alpha. Pearson's correlations were calculated and analyzed to assess the strength and direction of the relationship between the variables in this study as well as to identify any possible issues of multicollinearity. Due to the planned hierarchical multiple regression analysis the data were analyzed to check for violations to the conditions for and assumptions of multiple regression. The results of the descriptive analysis and preliminary data exploration are presented in chapter four.

Following these preliminary analyses, this study utilized hierarchical multiple regression analysis to answer the phase one research questions. Multiple regression is a useful analytic method often used in the social sciences when the researcher seeks to explain the variance in a phenomena, such as teacher practice, as a result of variation in other variables (Keith, 2006). Advantages of using multiple regression are the inclusion of multiple independent variables into

a model to explain the variance in the dependent variable, independent variables can be categorical or continuous, and it is an appropriate method for analysis of non-experimental data (Keith, 2006). Using a hierarchical approach allows for the researcher to enter variables in blocks or steps to determine to what extent new groups of variables improves upon the prediction, or explanation, of the previous groups of variables (Leech, Barrett, & Morgan, 2008; Petrocelli, 2003).

For this study, teachers' levels of reform-based practices were regressed on teacher background, local context, and policy related variables. In order to understand the nature of educational change as a result of reform efforts, it is imperative that researchers consider how teachers' backgrounds, teacher thinking, and the various contexts of reform (both structural and cultural) interact to affect the outcomes of reform efforts (Woodbury & Gess-Newsome, 2002). Once such desired change resulting from reform efforts, is a change in the nature of teachers' instructional practices. Following these considerations and using teacher socialization as a theoretical lens, the goal of this hierarchical regression model analysis was to understand how the various aspects of learning to teach and the contexts in which these processes occur, interact to explain the range of teachers' enactment of reform-based practices.

The independent variables operationalized above were entered sequentially into the regression analysis in groups or blocks of variables in five steps. Entering the variables in this manner facilitated an understanding of how each group of variables adds to the prediction above and beyond the previous blocks of variables. The following is the order of entry for the predictor variables groups:

Step 1: Teacher's Personal Background characteristics – Teachers' gender, Teachers' race, teachers' level of science content knowledge

Step 2: Teachers' Professional Background characteristics – Teachers' highest degree earned, university of teacher preparation, and number of years of teaching experience

Step 3: Beliefs and Efficacy for teaching – Teachers' beliefs about reform-based teaching and learning, and teachers' sense of preparedness for teaching science

Step 4: Local context of teaching- school setting type, school culture/climate scaled variable, quality of professional development scaled variable, amount of professional development, science content specific professional development, and level of professional autonomy

Step 5: Policy Environment – instructional influences on teaching scaled variable

As designed, this regression model tried to parse out the separate as well as the combined influence of various contexts of teacher socialization by looking at one product of the socialization process, teachers' instructional practices. The sequential order of this regression was based on a causal model following logic, time precedence, and previous research suggesting the order of entry of variables (Petrocelli, 2003). Research has indicated that the kinds of practices teachers' implement in the classroom are a result of various socialization forces from many contexts, even before individuals select teaching as a desired profession. Considering temporal precedence, the first step of this model controlled for important personal background variables that are either static, or occurred prior to a formal or more purposeful participation in the process of teacher socialization. As teachers begin to take part in their initial teacher preparation they enter a formalized socialization into teaching that extends across the



professional learning continuum of learning to teach (Feiman-Nemser, 2001). This professional learning continuum can be viewed as a larger system of teachers learning to take on the role of a teacher. Scholars are not in agreement about the relative influence of each context or layer in this system on teachers' eventual classroom practice.

Teachers' professional background characteristics were entered in the second step of this model to begin to understand how each context of this learning continuum influence teachers' practice. These professional variables entered in a block are often noted as teacher quality levers and are independent of the local context of teaching. Their entry in the second step was due to logic and temporal precedence. Formal socialization into the teaching profession begins with preservice teacher education. The value of teacher education programs contribution to the beliefs and behaviors of teachers' post graduation has largely been critiqued as having little impact on teachers' eventual classroom practices (Zeichner & Tabachnick, 1981). However, recent research indicates that specific teacher education programs or program components can positively influence their graduates classroom teaching practices and beginning teaching competencies (Brouwer & Korthagen, 2005). The three teacher preparation programs represented in this study worked to develop teachers with strong reform-based instructional practices, however they differed in their program design and components. This study viewed teacher education as an intervention in the teacher socialization process, assessing the degree to which this intervention can influence teachers' eventual classroom practice in a manner that is more typical of research on best practices in science teaching.

The decision of when to enter beliefs variables into the model was not clear-cut. Though research indicated a strong relationship between beliefs about teaching and learning, and teachers' classroom practices, the nature of this relationship is not as clear. Some argue beliefs

interact with practice at various points in the learning to teach continuum and may have a dialectic relationship (Mansour, 2009). Teachers' beliefs about and efficacy for teaching were entered in the third step of the model to reflect what was gained as a result of the teacher preparation program to bridge the transition from professional preparation to in-service teaching. Research has indicated that a central task for teacher preparation is to help preservice teachers examine their beliefs critically in relation to their vision of good teaching (Feiman-Nemser, 2001). Entering these variables at this point in the model was based on research and logic to focus on the ways in which beliefs developed as a result of their preparation affect eventual classroom practice.

The variables related to teachers' local school context were entered next in step four as it is the next logical progression in the learning to teach continuum influencing teachers' socialization. This additional block of variables adds another layer of understanding regarding how the kinds of practices teachers implement are affected by the structure and culture of their local school context. The local school context has been identified in the literature as having a "dominant influence" on teacher behavior. There are many critiques about the transfer of knowledge, beliefs, and practices learned in teacher preparation to the local context of teaching, with research claiming what is gained in teacher preparation is "washed out" by the school context (Zeichner and Tabachnick, 1981, p. 7). Feiman-Nemser, Schwille, Carver, and Yusko (1999) claim that teacher socialization into the school contexts focuses on the "occupational setting and professional community which new teachers are entering, the messages they received about what it means to be a teacher, and how these messages influence their emerging identity and practice" (p. 14). This step aids in answering the research questions as stated to understand

beyond personal and professional variables, how factors related to teachers' socialization in the local context add additional explanation to the enactment of reform-based practices.

The policy related instructional influences variable was entered last, as a more distant influence for teachers' practice. Research has shown that the response by school districts to changing policy environments, particularly with recent focus dominated by accountability measures, could add additional explanation regarding the socialization experiences teachers' encounter beyond just the local context that influence their practices (Woodbury and Gess-Newsome, 2002).

Analysis of the data illustrated how well the entire regression model explains the variance in teachers' practice and the separate contributions of each variable to the prediction of teachers practice. The  $R^2$  change helped to determine if the amount of variance in teachers practice can be explained by all the predictors and each group of predictors. The regression coefficients were analyzed to determine which of the variables significantly contributed to the prediction the most. The regression coefficients also described what change in these predictor variables accounts for what change in the outcome variable. The goal of this analysis was to gain a better understanding of the kinds of factors that can help explain the enactment of reform-based teaching practices by secondary science teachers. A secondary goal of this analysis was to aid in the selection of a small sample of teachers for further qualitative analysis in phase two of this study.

## **Phase Two: Qualitative Study**

### **Design**

The second phase of this study was qualitative in nature. As designed, it built on the analysis from the first phase by providing an in-depth analysis of factors related to teachers' use of reform-based teaching practices to help explain the variation in levels of practice exhibited by this sample of teachers. In this phase of the study, teachers were purposefully selected to best develop a deeper understanding of the problem and help to answer the research question (Creswell, 2009). The qualitative design of phase two employed instrumental multi-case study analysis of selected teachers using interview data from four separate interviews conducted during the IMPPACT project data collection (Stake, 1995). This design allowed for an "in-depth exploration," comparing and contrasting multiple cases to "illuminate" the issue of the development and implementation of reform-based teaching practices (Creswell, 2008, p. 476). This multi-case study analysis was conducted to answer the research questions pertaining to phase two, and is combined with analysis and results from phase one, in the discussion chapter of this research study.

### **Sample**

In a sequential explanatory mixed-methods design, data from the two research phases are often connected when the researcher uses the results of data analysis from the quantitative phase of the study in the identification of participants for the qualitative follow up phase of the study and the subsequent analysis (Creswell, 2009). Utilizing maximal variation sampling, teachers were selected that differed on some characteristics or trait; in this case they differed by level of reform-based teaching practices. Teachers' scores on the dependent variable from phase one facilitated the selection of the case study sample for the qualitative follow up investigation.

Selecting extremes cases from the quantitative data for further qualitative analysis, such as high and low scores from the dependent measures, is a common approach in a mixed-methods explanatory research design (Creswell, 2008). This sampling strategy allowed me “to present multiple perspectives of individuals to represent the complexity of our world” (Creswell, 2008, p. 214).

Using maximal variation sampling, the six case study teachers were selected based on their scores from the dependent variable of the regression model, which was the level of teachers’ reported use of reform-based teaching practices. This sampling strategy facilitated the selection of teachers whose reported use of reform-based instructional practices represented a range of enactment (see Table 9). Of the 37 IMPPACT study in-depth teachers, 33 of these teachers were a part of the quantitative study sample. Of these 33 teachers, 18 were identified as a part of the current study’s phase one quantitative sample ( $n=120$ ) whose practices were near the low, mean, and high dependent variable scores. Three IMPPACT in-depth teachers with scores on the dependent variable near the mean value were initially identified. The two teachers closest to the mean score, who had a full set of interview data, were selected. These two teachers, Mark and Amanda, were selected to reflect teachers who scores were near the mean of the distribution of scores. Of interest as well were the scores that fell towards the low and high tails of the score distribution. In-depth teachers whose scores fell at least one standard deviation below the mean were identified as potential cases ( $n=9$ ) as were teachers who scores were at least one standard deviation above the mean ( $n=6$ ) (see figure 6). After forming these groups of IMPPACT in-depth teachers with low and high levels of reform-based practice, I identified all of the teachers who had a full set of interview data necessary for the case study analysis. Once these teachers were identified, the other four case study teachers were selected based on those

teachers within this group whose scores were farthest from the mean. Alexander and Heidi were selected to represent teachers who reported low levels of reform-based teaching practices, while Matthew and Stephen were selected to represent teachers who reported high levels of reform-based teaching practices. The phase two sample selection process as described above was limited to the IMPPACT in-depth sample participants who had full sets of data for all four interviews used in the qualitative data analysis for this study. In some instances this meant that in-depth teachers whose scores were the most extreme may not have been selected due to lacking the necessary interview data for analysis. This also meant that each university was not equally represented in the phase two sample. The UI graduates are only represented by one teacher in this sample for several reasons. Of the two eligible from the high practice teachers, only UI 2-02 has a full set of interview data. Likewise, from the low practice teachers, there were two UI in-depth teachers that fell within this range, yet they each lacked at least one interview transcript necessary to be included in the phase two sample. There was one in-depth NCSU teacher who fell within the high practice range; however this teacher was also missing at least one interview from the set necessary to be included (see figure 6).

**Table 9**  
*Phase Two Study Sample*

Teacher	Level of Practice	Dependent Variable Score
Alexander	Low	41
Heidi	Low	44
Mark	Mean	59
Amanda	Mean	60
Matthew	High	88
Stephen	High	94

Note. Mean score on level of reform-based instructional practice for phase one sample= 62; 1 Standard Deviation below the mean= 47; 1 Standard Deviation above the mean=77

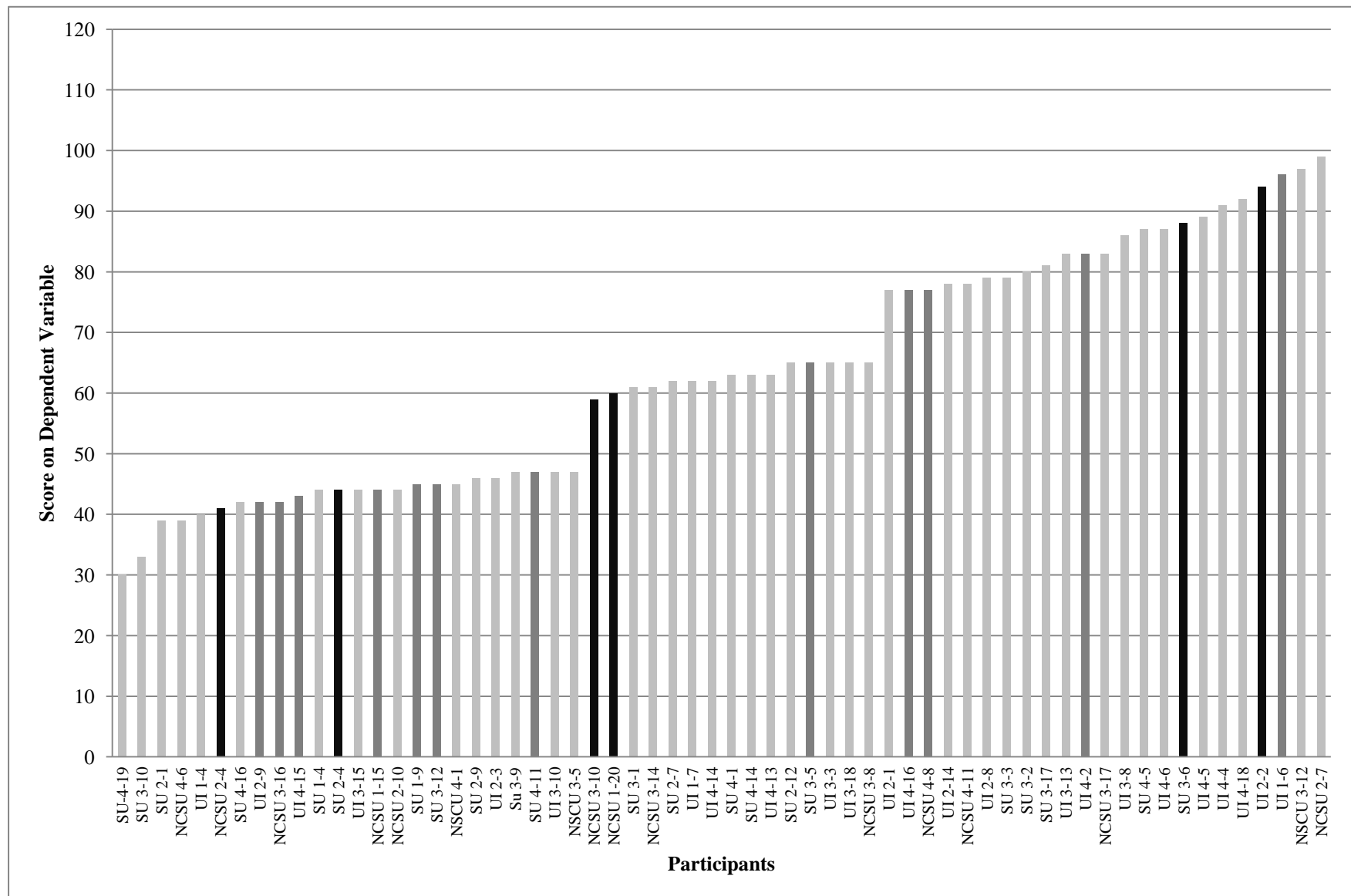


Figure 6. Phase Two Possible Sample Participants - Mean score on level of reform-based instructional practice for phase one sample= 62; 1 Standard Deviation below the mean= 47; 1 Standard Deviation above the mean=77. **Light Gray Bars** = participants in phase one sample (not IMPACT in-depth teachers), **Dark Gray Bars** = participants in phase one sample (IMPACT in-depth teachers), **Black Bars** = participants from phase one sample selected for phase two qualitative sample

## **Data and instrumentation**

The data for the multiple case studies were drawn from four separate interviews conducted with IMPPACT participants that were in the sub-sample (in-depth) population. These four interviews address different facets of the teachers' backgrounds and experiences in their teacher development. The following descriptions of the four interviews are taken from the IMPPACT Project instrumentation package:

*The IMPPACT Introductory Interview* was developed by the IMPPACT research team to try to capture some of the early life history of the teachers that related to their experiences as a student/developing teacher. This six – nine question interview (cohorts three - four were asked three additional questions regarding their feelings of preparedness to teach as they were already graduated from their program at the beginning of the IMPPACT study) was conducted by a member of the IMPPACT research team in a semi-structured format, and was guided by the survey protocol of questions (Appendix D). This Introductory Interview was conducted in either August or September of the second year of the study (first year was the pilot study year) with all participants in the sub-sample, or in-depth teachers. A majority of the interviews were conducted face-to-face lasting around 30 minutes. When this was not possible the interviews were conducted over the phone. All the interviews were audiotaped and transcribed for future coding.

*The Preservice Program Interview* was originally a part of a research protocol of the same name from the Salish I Research Project (Yager & Apple, 1993). The IMPPACT Project modified the original interview protocol, using only questions 1-17 for data collection. The interviews were conducted by a member of the IMPPACT research team in a semi-structured format, and were guided by the survey protocol of questions (Appendix E). This Pre-service



Program Interview was administered in year two of the study (first year was the pilot study year) to all participants in the sub-sample, or in-depth teachers. A majority of the interviews were conducted face-to-face lasting around 35 - 55 minutes. When this was not possible the interviews were conducted over the phone. All the interviews were audiotaped and transcribed for future coding.

*Reflections on Preservice Program Experiences (RoPPE) Interview* was developed by Tillotson, Penick, and Yager, 2007. This interview protocol (Appendix F) asked participants' to describe how experiences within their science teacher preparation program influence their beliefs and practices. It was developed as an exit-interview to gain perspective on specific program features. The 22 questions are focused on four areas: teacher education /science education experiences; field experiences/student teaching; external factors; and general reflections on teaching. This interview was used in the final spring of data collection after all other data collection was complete, and was offered to all participants in the study. The RoPPE was administered to 31 graduates of the Syracuse program, 30 graduates of the North Carolina program, and 15 graduates of the Iowa program. All the interviews were audiotaped and transcribed for future coding.

*Beliefs-Nature of Science Interview (BNOS)* was an interview protocol (Appendix G) that asked participants' to describe their evolving beliefs about effective science instruction, their philosophy on learning and how students learn, and their views on the nature of science. The Beliefs and Nature of Science Interviews are based on the Teachers' Pedagogical Philosophy Interview (TPPI) (Richardson & Simmons, 1994) and the shortened version of the TPPI, known as Teachers' Beliefs Interview or TBI (Luft, Roehrig, & Brooks, 2003). Opening statements were added to provide the participant with a standard and appropriate amount of background

information related to the study. A multi-pronged question related to the role of external factors was also added to the Beliefs Interview to elicit information on the perceived influence of outside factors on the teachers' beliefs and practices.

The interview consists of seventeen questions. Due to the relatively brief nature of the Beliefs and Nature of Science Interviews, the IMPPACT Project team conducted both interviews in one session. The interviews are independent documents and do not need to be administered together or analyzed together. This current study utilized only the Beliefs portion of the BNOS, which contains the question related to the role of external factors of the school environment. The interview was repeated annually during the spring semester with the in-depth participants to chart yearly changes. A majority of the interviews were conducted face-to-face lasting around 40 - 50 minutes. When this was not possible the interviews were conducted over the phone. All the interviews were audiotaped and transcribed for future coding. The BNOS was administered to 57 teachers in 2006-07, 39 teachers in 2007-08 and 52 teachers in 2008-09. Due to the timing of the SEC survey data utilized for the phase one analysis, the beliefs interviews from the 2008-2009 data collection were used in this qualitative analysis to match the 2008-2009 SEC survey data.

### **Qualitative Data Analysis**

Once the six teachers were identified, all the interview data for each teacher were obtained from the IMPPACT Master Database and transferred into NVivo 10, a qualitative research software tool used to aid qualitative and mixed-methods analysis. The qualitative analysis of the interview data occurred on various levels. First, I read through all the interview data for each participant. In this first reading of the data a closed coding system was initially utilized, coding the participants' interview data according to the spheres of influence (personal

and professional backgrounds, local context, and state policy influences) which identified forces that influence teacher socialization with regards to teacher practice. This initial coding/grouping facilitated organization of this data to look for patterns within these spheres of influence, and compare and contrast the ways these socialization forces relate to teachers' instructional practices as guided by previous research studying this phenomena (Achinstein, Ogawa, & Speiglmán, 2004). These groupings according to socialization forces each became a parent node in NVivo, and allowed the qualitative analysis to initially align with the data from phase one.

Following this initial coding, I read through all the transcripts again and open coded within each of the three main spheres by creating smaller codes or nodes inside these parent nodes. This stage of qualitative analysis was guided by the quantitative results of the phase one study. Specific attention was paid to coding related to the statistically significant variables from the phase one regression model as well as other codes, which added depth to what was not measured quantitatively. Using an analytic inductive approach, codes were collapsed under each parent node into themes that emerged among the various spheres of influence within each teacher's case (Bogdan & Biklen, 2007). Following this coding and theme development, descriptive cases of each teacher were developed that detailed each case teacher's description of their practices, and the themes related to their backgrounds, local contexts, and state policy environment. Finally, I conducted a cross-case comparison, analyzing similarities and differences among the emerging themes as they related to the various socialization experiences teachers had to add a nuanced description and explanation for the variation seen in their implementation of reform-based instructional practices (Creswell, 2008). This cross-case comparison resulted in broader themes related to explaining the variation in teachers' practices and became the basis for the findings presented in chapter five.

## **Limitations**

As is true of any qualitative investigation, there were limitations to this phase of the research which influenced the clarity and quality of the conclusions drawn as a result of this analysis. Some of these limitations arose due in part to my position as the researcher as well as the use of existing data for the basis of the qualitative analysis.

I am a former seventh grade life science teacher. I am also a graduate of one of the teacher preparation programs of interest in this study. Prior to engaging in this research, I was intimately aware of the nature of this teacher preparation and the faculty. Upon returning to pursue my PhD in Science Education at this same University, I was hired as a Research Associate on the IMPPACT project. Though I was not involved in the design of the IMPPACT study or data collection, I worked with the IMPPACT research team in the final two years of the study coding, cleaning, analyzing, and writing about the data. According to Bogdan and Biklen (2007), “qualitative researchers try to acknowledge and take into account their own biases as a method of dealing with them” (p. 38). My own personal biases due to the experiences I have had and my subjectivity may have come to play in the analysis and presentation of the data. Using multiple sources of interview data for each participant as well as using teacher socialization as a lens to guide my analysis aided in my attempt to limit this personal bias. To further limit this bias, future research could seek greater triangulation of the data sources as well as collaboration with other researchers to a review and analyze data.

Another limitation to the qualitative phase of this study was the phase two sample selection process. With the purposeful sampling method used, ideally I would have liked to have selected a more even representation of teachers across the three universities. It would have made

for rich comparisons to have had more UI teachers in the sample as well as UI teachers at the low end of the practice continuum and NCSU teachers at the high end of the practice continuum. However, as mentioned previously, the phase two sample was restricted to the teachers who were in the original IMPPACT in-depth sample who had full sets of data for the four interviews used in this analysis. This limited some of the purposeful sampling choices that I was able to make.

## **CHAPTER FOUR: QUANTITATIVE DATA ANALYSIS AND RESULTS**

The purpose of this mixed-methods study was to determine the relative influence of secondary science teachers' characteristics, backgrounds, and experiences across their teacher development to explain the range of teaching practices exhibited by graduates from three reform-oriented teacher preparation programs. This chapter presents the procedures and results from the quantitative first phase of this study. The results presented include description of the sample, descriptive statistics for all key study variables, and analyses related to the hierarchical multiple regression employed to answer the phase one research questions. The quantitative results from phase one of this study will be discussed in chapter six in combination with the qualitative findings from chapter five.

The data for this study were gathered from the IMPPACT master database. It was determined that of the broader IMPPACT sample, 120 teachers completed both the SEC and BARSTL surveys, from which a majority of the data used for these analyses were gathered. The NSTEPG survey provided data for two of the independent variables for the study; school setting, and level of professional autonomy. Of the 120 teachers who took both the SEC and BARSTL, 115 also completed the NSTEPG. The analysis for this study tried to preserve as much of the data from these surveys, using the 120 teachers for whom all the dependent variable data were present as well as a majority of the independent variable data. Maintaining the 120 case sample size for analysis was done to maximize the statistical power of the study. This decision resulted in the two independent variables mentioned above from the NSTEPG (level of professional autonomy and school setting) with 4.2% missing data. Sensitivity analyses were computed to determine the effect of this missing data. Regression models were run without the missing cases and also with a mean/mode substitution for the missing cases. The sensitivity analysis indicated

very little change to the overall model in either instance. For the analyses that follow, pairwise deletion was utilized due to the missing cases on these variables.

As mentioned in chapter three, each IMPPACT participant was given a unique identifier. This identifier was used to link all the separate files from each survey. All the raw survey data were combined into one SPSS file. Using the raw survey data, all independent variables were coded and scales created according to the methods outlined in chapter three (see Table 6). As outlined in Chapter three, the dependent variable was then computed by first computing the three subscales from the SEC; active learning, scientific thinking, and communicating scientific thinking. These three subscales were then summed to form the dependent measure, level of reform-based instructional practices (see Table 7).

### **Descriptive and Exploratory Data Analysis**

After all the raw data were entered into SPSS, coded, and scales created, the data were analyzed to check for errors, outliers, and missing data. Each item used in the scaled variables was also analyzed for number of teachers responding to each item as well as the percentage of the sample this represented. These analyses are presented in Tables H1-H6 in the Appendix H. Beyond the five missing cases for the two independent variables discussed previously, no errors or inconsistencies were detected in this analysis. Descriptive statistics were calculated regarding the demographic characteristics of the sample as well as the key study variables including minimum and maximum values, ranges, means, standard deviations, and skewness. Finally analyses were conducted to assess the extent to which the data met the assumptions of multiple regression analysis.

### **Sample Demographic Characteristics**

Both the SEC and NSTEPG surveys were used to gather data about the characteristics of the secondary science teachers in this sample and the context of the schools in which they taught at the time of the IMPPACT study (Table 10). Of the 120 teachers in the study, a majority were female (65%) and identified themselves as white (94.2%). The characteristics of this sample are representative of other large national samples of science teachers (Banilower et al., 2013). As mentioned in chapter three, teachers in this sample were graduates of three different teacher preparation programs. Of the 120 teachers, 39.2% of the teachers were graduates of Syracuse University, 33.3% graduated from the University of Iowa, and the remaining 27.5% graduated from North Carolina State University. With respect to the highest degree held, 33.1% of teachers held bachelors degrees, 50.4% identified possessing a masters degree, 9.9% held multiple masters degrees, 1.7% held either a Ph.D. or Ed.D., and 4.1% responded other advance degree. Due to the majority of teachers possessing at least one masters degree and the low responses rates for advanced degrees other than masters, these categories were combined and recoded into a dichotomous variable, bachelors or masters and higher (66.7% of the total sample). About 45% of teachers reported that they were in their first two years of teaching. Of the remaining teachers 24.2% had 3-5 years of teaching experience, 16.7% had 6-8 years of experiences, and 14.2% had been teaching for 9 or more years at the time of the study. More teachers in this sample (41.7%) identified the school context in which they taught as a suburban setting, as opposed to an urban setting (21.7%) or rural setting (32.5%). There were five missing cases related to this variable.



Table 10  
*Descriptive Statistics for Secondary Science Teachers and School Settings*

Variable	n	Percent
Race		
White	113	94.2
Non-White	7	5.8
Gender		
Female	78	65
Male	42	35
Highest Degree Earned		
Bachelors	40	33.3
Masters or higher	80	66.7
Years of Teaching Experience		
Less than 1 year	20	16.7
1 – 2 years	34	28.3
3 – 5 years	29	24.2
6 – 8 years	20	16.7
9 + years	17	14.2
University of Preparation		
SU	47	39.2
UI	40	33.3
NCSU	33	27.5
Type of School/District <sup>a</sup>		
Urban	26	21.7
Suburban	50	41.7
Rural	39	32.5

Note. <sup>a</sup> Five missing cases

### **Descriptive Statistics for Key Study Variables**

The primary goal of this study was to understand and explain the variation seen in secondary science teachers' instructional practices. Teachers' self reported level of reform-based instructional practices served as the dependent measure in this study. This scale created from the summed combination of three subscales had a total possible score of 120. For the teachers in this

sample, the descriptive statistics for this scale show that on average teachers are not frequently implementing reform-based instructional practices in the secondary science classroom,  $M = 62.28$ ,  $SD = 15.09$ . The study used independent variables related to the demographic variables described in Table 10, as well as several scaled variables related to teachers' efficacy/beliefs, their school context, and policy related instructional influences. The descriptive statistics for these variables are presented in Table 11.

Table 11  
*Descriptive Statistics for Study Variables*

Variable	n	M	SD	Range	Min	Max	Skew
Dependent							
Reform-based instructional practices	120	62.28	15.09	69	30	99	.362
Independent							
Science content knowledge	120	20.97	7.77	48	0	48	.520
Beliefs about reform-based science teaching	120	94.32	7.68	37	79	116	.324
Sense of preparedness to teach science	120	13.99	3.16	14	4	18	-.790
Instructional influences	120	23.61	5.19	25	8	33	-.509
School culture and climate	120	21.18	5.95	31	1	32	-.783
Level of professional autonomy <sup>a</sup>	115	5.18	1.34	5	2	7	-.567
Amount of professional development	120	3.22	1.64	5	0	5	-.552
Science content specific professional development	120	15.73	6.89	33	0	33	.132
Quality of professional development	120	20.82	7.39	34	0	34	-.678

Note. <sup>a</sup> 5 missing cases

## Findings for Research Questions

The goal of the first phase of this study was to examine the separate as well as the combined influence of secondary science teachers' characteristics, backgrounds and experiences across their teacher development on teacher's use of reform-based instructional practices. The following research questions were the focus of this analysis:

- 1) How much variation in secondary science teachers' use of reform-based instructional practices is accounted for by a set of personal background variables (gender, race, and level of science content knowledge), a set of professional background variables (teacher preparation program, type of certification degree, and years of experience teaching), a set of efficacy/beliefs variables (sense of preparedness and beliefs about reform-based science teaching), a set of school contextual variables (school context, school climate/culture, and professional development opportunities), and a policy related variable (policy related instructional influences)?
- 2) Do school contextual variables and policy influences explain additional variation in teacher practices after accounting for the variation in practice due to personal and professional background variables and efficacy/beliefs variables?

It was hypothesized that though all of these factors would contribute to explaining the variation seen in teachers' instructional practices, school contextual variables and policy related influences would contribute additional explanation above and beyond teachers' personal, professional, and beliefs and efficacy for teaching. The alpha level was set to .05 for all the statistical analyses for this phase of the study.

To answer these research questions, a hierarchical multiple regression analysis was conducted to assess the individual and combined effect of the sets of independent variables. In order to run the hierarchical regression analysis, several analyses were first conducted to check for violations to the conditions for and assumptions of multiple regression: assumption of linearity, normally distributed errors, assumption of homoscedasticity, and lack of multicollinearity (Leech et al., 2008; Osborne & Waters, 2002).

In order to conduct a multiple regression analysis, the continuous dependent variable of interest to the study must be a normally distributed scale level variable (Leech et al., 2008). A histogram was created and visually inspected to check that the dependent variable was normally distributed. In addition to visual inspection of the histogram, skewness statistics were also calculated to assess the approximation of normality. The skewness for this variable was found to be less than plus or minus one, indicating that the dependent variable was not significantly skewed and was approximately normal (Leech et al., 2008). After ascertaining the dependent variable met the condition of normal distribution necessary to continue with the planned regression analysis, the violations to the assumptions of multiple regression were assessed.

Perhaps the most important assumption underlying the use of multiple regression is the necessity of a linear relationship between independent variables and the dependent variable to correctly estimate the relationship between these variables (Keith, 2006; Osborne & Waters, 2002). A scatterplot matrix was developed to assess the linear relationship between all the independent variables and the dependent variables proposed in this analysis. Inspection of the scatterplot indicated that this assumption was met as straight lines fit each of the plots as opposed to curved lines (Leech et al., 2008). An inspection of the plots of the standardized residuals and

the standardized predicted values also indicate a linear relationship (Osborne & Waters, 2002). In general the assumption of linearity was met through both of these checks.

In addition to the assumption of normality for all the continuous variables in a study, multiple regression analysis rests on the assumption of a normal distribution of the residuals or errors (Keith, 2006). To assess this assumption, the standardized residuals were saved and used to create histogram. Inspection of this graph indicated an approximation of normality. In addition, an inspection of the normal Q-Q plot of the residuals indicated little deviation from the straight line also indicating the assumption of residual normality had been met.

Another important assumption with regards to conducting multiple regression is having equal variance of errors around the regression line for all values of the independent variables, or homoscedasticity. A scatterplot of the standardized residuals by the standardized predicted value can be examined to check for uniform distribution of the residuals. Extreme heteroscedasticity, indicated by a distinct non-random pattern of residuals across the values of the independent variable, can “distort findings and weaken analysis” (Osborne & Waters, 2002). The residual scatterplot created for this study to check for this assumption revealed very little variance of errors. Due to the lack of detection of obvious heteroscedasticity, it was determined the assumption of homoscedasticity was met.

A final condition of concern for conducting multiple regression analysis is detecting the presence of multicollinearity. When using various independent variables in the prediction or explanation of a dependent variable, multicollinearity occurs when independent variables are highly inter-correlated, containing some of the same information (Leech et al., 2008). How much these variables overlap and the degree to which they correlate can lead to misleading

results in the regression (Keith, 2006). One way multicollinearity can be detected is by calculating the correlation coefficients between independent variables (Kahane, 2008). Typically high correlations between independent variables detected in a correlation matrix ( $r > .5$  or  $.6$ ) can be an indicator of a potential problem of multicollinearity (Leech et al., 2008). Yet moderate to high correlations are not always a sufficient indicator of multicollinearity. This condition can be present even when correlations are not extremely high, particularly when “bizarre” or “strange” results are noticed in the regression coefficients (Keith, 2006). One possible “strange” result is the change in sign for the parameter estimate or regression coefficient than what was expected from the calculated correlation coefficient. This change in sign is another possible indicator of the presence of multicollinearity (Lipovetsky & Conklin, 2003).

In checking for the presence of this condition in the data for this study, initial inspection of the correlation coefficients did not cause great concern that multicollinearity was present (Table 12). Only two variables were highly correlated, years of teaching and amount of professional development ( $r = .521$ ,  $p < .01$ ). Teachers who had been teaching longer would have had more opportunities for professional development. However, after running an initial model, the regression coefficients for two other variables yielded some “strange” results, or the opposite of what was expected. While the signs of the correlation coefficients for relationship between the dependent variable and independent variables amount of professional development and school climate and culture were positive, when added to the regression analysis the signs for the corresponding regression coefficients changed to negative. This unexpected result was indication that multicollinearity might be a problem for these variables. Closer inspection of the amount of professional development variable indicated low to moderate correlations with the other two measures of professional development; the content specific nature of professional

development and the quality of professional development. Yet the amount of professional development was not found to be significantly correlated to the dependent variable. The school culture and climate variable yielded this same pattern of sign switching. This variable was moderately correlated with another measure of school climate, the level of professional autonomy experienced by teachers. The school culture and climate variable was also not significantly correlated to the dependent variable.

Due to the unexpected sign switch in these two variables from positive to negative, it was determined that multicollinearity was present. Leech et al. (2008) advise to eliminate problematic variables if it does not make conceptual sense to combine the variables, particularly in a situation in which the variable has a low correlation with the dependent variable and stands to reduce the power of the analysis and predictive power of other independent variables. Given that the amount of professional development and school culture and climate were not significantly correlated with the dependent variable, and therefore not likely to help explain the variation seen in reform-based science teaching, the decision was made to eliminate them from the regression analysis to preserve the predictive power of the other independent variables related to the school context step of the regression.

### **Pearson correlations**

Prior to running the hierarchical multiple regression analysis, correlations were calculated to determine the linear relationships between all the continuous and dichotomous variables proposed for use in the regression analysis. The significance of the correlation coefficients is used to determine the strength and direction of the association between variables rather than the existence of a cause/effect relationship between the variables (Sprinthall, 2007). Table 12 presents the correlations between the personal and professional background variables,

efficacy/beliefs variables, school contextual variables, and policy influences and the level of reform-based instructional practices. Interpretation of the correlation coefficients followed Cohen's (1992) guidelines: an  $r$  value of .10 indicating a low correlation, an  $r$  value of .30 indicating a moderate correlation, and an  $r$  value of .50 indicating a high correlation. Five of the independent variables were significantly correlated to the dependent variable, level of reform-based instructional practice. Of these five, three variables were found to be moderately correlated with the level of reform-based instructional practices: teacher's sense of preparation to teach science ( $r = .318, p < .01$ ), science content specific professional development ( $r = .389, p < .01$ ), and the quality of professional development ( $r = .385, p < .01$ ). Policy related instructional influences ( $r = .243, p < .01$ ), and level of professional autonomy ( $r = .223, p < .05$ ) were found to have a low correlation to the dependent variable. There were several other moderate correlations among the independent variables: (a) teachers with a masters degree or higher had higher levels of science content knowledge ( $r = .401, p < .01$ ), (b) teachers who had taught longer experienced more hours of professional development ( $r = .521, p < .01$ ), (c) teachers that reported experiencing a more trusting and supportive school culture and climate also experienced higher levels perceived professional autonomy ( $r = .321, p < .01$ ), and (d) teachers that indicated higher quality professional development opportunities had more years of teaching experience ( $r = .306, p < .01$ ), experienced more total hours of professional development ( $r = .303, p < .01$ ), and experienced more science content specific professional development ( $r = .481, p < .01$ ).



Table 12  
*Pearson Correlation of Variables*

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Race	—													
2 Gender	-.034	—												
3 Highest Degree	-.126	-.111	—											
4 Years teaching experience	.088	.136	.032	—										
5 Science content knowledge	-.008	.067	.401**	.113	—									
6 Beliefs	.008	.134	.147	-.152	.149	—								
7 Sense of prep	.068	.024	.049	.282**	.044	-.108	—							
8 Instructional influences	.225*	.005	-.218*	.094	-.119	-.131	.110	—						
9 School culture and climate	.022	.166	-.151	.044	-.093	.138	.154	.104	—					
10 Level of autonomy	.020	.029	.025	.012	-.016	.079	-.059	-.057	.321**	—				
11 Amount of PD	.032	.020	.007	.521**	.071	-.089	.109	.114	-.028	-.024	—			
12 Science content PD	.062	.032	-.173	.125	.045	-.056	.206*	.252**	.084	.034	.272**	—		
13 Quality of PD	-.028	-.062	-.092	.306**	.163	-.026	.204*	.137	.194*	.023	.303**	.481**	—	
14 Reform-based instructional practices	.066	.057	-.038	.150	-.007	.022	.318**	.243**	.167	.223*	.081	.389**	.385**	—

Note. Prof. = Professional, PD=professional development

\*  $p < .05$ . \*\*  $p < .01$ .

### **Hierarchical multiple regression results and analysis**

A five step hierarchical multiple regression was computed in order to investigate the individual and collective contributions of a combination of personal background variables, professional background variables, efficacy/beliefs variables, school contextual variables, and policy related instructional influences to the level of secondary science teachers' use of reform-based instructional practices. Table 13 presents the results of the regression analysis.

When entered alone, the personal background variables (gender, race, and science content knowledge) did not significantly predict reform-based science teaching,  $F(3,111) = .299$ ,  $p = .826$ ,  $R^2 = .008$ . The addition of the professional background variables in step two improved upon explaining variation in use of reform-based science teaching practices,  $R^2$  change = .088,  $F(4, 107) = 2.598$ ,  $p < .05$ . The two step model was not statistically significant,  $F(7,107) = 1.620$ ,  $p = .137$ . Teachers' sense of preparedness to teach science and their beliefs about reform-based teaching were added in step three. These variables improved the explanation,  $R^2$  change = .072,  $F(2,105) = 4.565$ ,  $p < .05$ . The three step model was statistically significant,  $F(9, 105) = 2.358$ ,  $p < .05$ . The fourth step included school contextual variables. These variables added additional explanation of the variation in teachers' practices,  $R^2$  change = .194,  $F(5, 100) = 6.085$ ,  $p < .001$ . The four step model was statistically significant,  $F(14, 100) = 4.057$ ,  $p < .001$ . After taking into account all the previous variables pertaining to personal and professional backgrounds, efficacy/beliefs, and school contextual variables, the addition of policy related instructional influences were added to the model. The policy related instructional influences did not significantly contribute to explaining variation in teachers' practice,  $R^2$  change = .016,  $F(1, 99) = 2.555$ ,  $p = .113$ .

The full five step model was statistically significant,  $F(15, 99) = 4.015$ ,  $p < .001$ , explaining 37.8% of the variation in secondary science teachers' use of reform based instructional practices. The five variables that significantly contributed to explaining variation in teachers' use of reform-based instructional practices in the full model were, attending University of Iowa for teacher preparation ( $\beta = .293$ ,  $p < .05$ ), sense of preparation for teaching science ( $\beta = .206$ ,  $p < .05$ ), the quality of professional development ( $\beta = .250$ ,  $p < .05$ ), science content focused professional development ( $\beta = .212$ ,  $p < .05$ ), and the level of professional autonomy ( $\beta = .214$ ,  $p = .01$ ). Comparison of the standardized regression coefficients,  $\beta$ , allows for determination of the relative effects of the independent variables on the dependent variable in a sample (Keith, 2006). Comparing the relative importance of the five significant predictors of reform-based instructional practices, attending the University of Iowa for teacher preparation predicts the highest increase in reform-based teaching practices, with each SD in this variable, resulting in .293 SD or (.293 \* 15.09 = 4.42 increase) in reform-based instructional practices. The quality of a teacher's professional development follows with one SD in quality of professional development predicting .250 SD (3.8 increase) in enactment of reform-based instructional practices. Following this logic, teachers' level of professional autonomy (.214 SD or 3.2 increase), level of content specific professional development (.212 or 3.2 increase), and sense of preparedness to teach (.206 or 3.1 increase) follow in order of their relative importance of predicting the enactment of reform-based instructional practices.

Table 13

*Five-Step Hierarchical Multiple Regression Model for Variables Predicting Reform-Based Instructional Practices*

Variable	B	SEB	$\beta$	<i>t</i>	$R^2$	$\Delta R^2$
<b>Step 1</b>					.008	.008
Gender	1.892	2.986	.060	.634		
Race	4.374	6.064	.068	.721		
Science Content Knowledge	-.020	.184	-.010	-.108		
Constant	61.783	4.20		14.712		
<b>Step 2</b>					.096	.088*
Gender	-1.707	3.141	-.054	-.543		
Race	1.763	6.015	.028	.293		
Science Content Knowledge	-.060	.200	-.031	-.299		
Highest Degree Earned	-2.272	3.809	-.071	-.597		
Years Teaching Experience	2.112	1.112	.181	1.898		
SU	2.206	4.267	.072	.517		
UI	10.019	4.108	.314	2.439*		
Constant	57.469	4.503		12.761		
<b>Step 3</b>					.168	.072*
Gender	-1.341	3.047	-.043	-.440		
Race	1.089	5.831	.017	.187		
Science Content Knowledge	-.044	.194	-.023	-.227		
Highest Degree Earned	-2.128	3.712	-.067	-.573		
Years Teaching Experience	1.101	1.134	.094	.972		
SU	1.260	4.143	.041	.304		
UI	9.147	4.187	.287	2.185*		
Beliefs about Reform-based Teaching	-.055	.200	-.028	-.277		
Sense of Preparedness to Teach	1.329	.449	.278	2.958*		
Constant	40.870	7.023		5.819		

(continued)

Variable	B	SEB	$\beta$	$t$	$R^2$	$\Delta R^2$
<b>Step 4</b>					.326	.194**
Gender	-.065	2.800	-.002	-.023		
Race	2.295	5.333	.036	.430		
Science Content Knowledge	-.204	.183	-.105	-1.117		
Highest Degree Earned	.490	3.398	.015	.144		
Years Teaching Experience	.015	1.070	.001	.014		
SU	3.184	3.801	.103	.837		
UI	9.580	3.782	.301	2.533*		
Beliefs about Reform-based Teaching	-.094	.180	-.048	-.522		
Sense of Preparedness to Teach	1.007	.414	.211	2.431*		
Urban	-1.552	3.332	-.043	-.466		
Suburban	-1.030	2.932	-.034	-.351		
Level of professional Autonomy	2.317	.921	.205	2.517*		
Quality of Professional Development	.514	.207	.252	2.488*		
Content Specific Professional Development	.520	.207	.238	2.514*		
Constant	17.466	8.394		2.081		
<b>Step 5</b>					.378	.016
Gender	-.002	2.779	-.000	-.001		
Race	.582	5.399	.009	.108		
Science Content Knowledge	-.191	.181	-.098	-1.051		
Highest Degree Earned	.714	3.374	.022	.212		
Years Teaching Experience	-.028	1.062	-.002	-.027		
SU	3.913	3.800	.127	1.030		

(continued)

Variable	B	SEB	$\beta$	$t$	$R^2$	$\Delta R^2$
UI	9.350	3.755	<b>.293</b>	2.490*		
Beliefs about Reform-based Teaching	-.055	.180	-.028	-.304		
Sense of Preparedness to Teach	.986	.411	<b>.206</b>	2.397*		
Urban	-1.465	3.307	-.041	-.443		
Suburban	-1.211	2.911	-.040	-.416		
Level of Professional Autonomy	2.419	.916	<b>.214</b>	2.642*		
Quality of Professional Development	.510	.205	<b>.250</b>	2.487*		
Content Specific Professional Development	.463	.208	<b>.212</b>	2.223*		
Instructional influences	<b>.407</b>	<b>.255</b>	<b>.140</b>	<b>1.599</b>		
Constant	8.186	10.153		.806		

Note.  $R^2 = .378$ , Adjusted  $R^2 = .284$

\*  $p < .05$ . \*\*  $p < .01$ .

### Summary

Chapter four presented the results of the first phase of a mixed-methods study designed to explain variation observed in secondary science teachers' use of reform-based instructional practices. The results of this chapter pertain to the quantitative analyses used to understand and explain this observed variation in practice. Data analyses presented in this chapter include descriptive statistics for the sample and key study variables, Pearson correlations, and hierarchical regression analysis. The hierarchical multiple regression analysis was used to assess

the individual and collective contributions of sets of personal, professional, efficacy/beliefs, school context, and policy related variables to this variation seen in instructional practices.

Research question one investigated: How much variation in secondary science teachers' use of reform-based instructional practices is accounted for by a set of personal background variables (gender, race, and level of science content knowledge), a set of professional background variables (teacher preparation program, type of certification degree, and years of experience teaching), a set of efficacy/beliefs variables (sense of preparedness and beliefs about reform-based science teaching), a set of school contextual variables (school context, school climate/culture, and professional development opportunities), and a policy related variable (policy related instructional influences)? The results of these analyses indicate that nearly 38% of the variation in secondary science teachers' use of reform-based instructional practices is significantly explained by the regression model. Teachers' personal background variables and the policy related instructional influences did not significantly explain teachers' enactment of reform-based teaching practices. Three blocks of variables, professional background, beliefs/efficacy, and local school context added significant contribution to explaining the variance in level of practice exhibited by teachers in this study. Teachers' professional background added 8.8% explanation to the variance in teachers' enactment of reform-based instructional practices, teachers' beliefs/efficacy for science teaching added an additional 7.2% to the explanation, and teachers' local school context added an additional 19.4% explanation.

Of the independent variables used in the full model, five variables significantly contributed to explaining the variation in practice. The following list of these five variables is arranged according to the greatest level of contribution to the explanation of variance in enactment of reform-based teaching practices: 1) graduation from the University of Iowa teacher

preparation program contributed most to explaining the variance in the enactment of reform-based instructional practices, 2) experiencing higher quality professional development predicted greater use of reform-based instructional practices, 3) perceiving higher levels of professional autonomy in the school context predicted using more reform-based instructional practices, 4) experiencing more science content focused professional development predicted greater use of reform-based instructional practices, and 5) possessing a greater sense of preparation for teaching science predicted an increase in the use of reform-based instructional practices.

The second quantitative research question investigated the additional contribution of school contextual variables and policy influences to explaining variation in teacher practices after accounting for the variation in practice due to personal and professional background variables and efficacy/beliefs variables. The results indicate the addition of school context variables did indeed significantly add an additional 19.4% to the explanation in variation in teachers' practice, while policy related influences did not. These data provide evidence that after taking into account the positive effects of teachers' preparation program and beliefs/efficacy for science teaching on teachers' enactment of reform-based instructional practices, several aspects of the local school context such as the quality and content focus of professional development and the level of teacher autonomy further explain teachers' instructional practices. Chapter six will further discuss these findings in combination with the qualitative findings from chapter five.



## **CHAPTER FIVE: QUALITATIVE DATA ANALYSIS AND RESULTS**

The purpose of this mixed-methods study was to determine the relative influence of secondary science teachers' characteristics, backgrounds, and experiences at key stages of their teacher development to explain the range of teaching practices exhibited by graduates from three reform-oriented teacher preparation programs. This chapter presents the results from the qualitative second phase of this study. Major themes presented in this chapter relate to the influence of socialization experiences across multiple learning-to-teach contexts on teachers' instructional practices. These findings will be discussed in chapter six in combination with the quantitative findings from chapter four.

The qualitative data analyzed in phase two of this study were drawn from an existing data set from the IMPPACT Project, a NSF funded five year mixed-methods study involving the collaboration of Syracuse University, the University of Iowa, and North Carolina State University. The IMPPACT project sampled a range of experience levels of graduates (n~150) from science teacher preparation programs at the above named universities, and followed these teachers from 2006-2007 through 2008-2009. Of this sample, a smaller subsample was identified for further in-depth analysis of teacher beliefs and practices related to science teaching. The goals of the IMPPACT project were to determine the longitudinal impact of preservice science teacher education programs on secondary science teachers and their students across various stages of teacher experience levels. The IMPPACT study database consists of both quantitative and qualitative data, including multiple repeated surveys, in-depth interviews, classroom and field observations, and samples of teacher and student work. Phase two of this current study utilized the multiple interviews collected from the in-depth sample of teacher participants. The analysis of these data was used to answer the following research question:

How do the factors identified in the phase one model related to personal backgrounds, local school context, and state policy environment contribute to explaining the differences in levels of reform-based science teaching exhibited by graduates from these three reform-oriented teacher preparation programs?

In the second phase of my research study, multi-case studies were used to further explore aspects related to secondary science teachers' use of reform-based teaching practices.

Following the hierarchical regression analysis of phase one, phase two provided an in-depth study of teachers' views regarding influences to their socialization into the teaching profession and the pedagogical practices resulting from this process through the analysis of multiple sources of interview data. In a sequential explanatory study design quantitative data from the first part of the study informs the data collection for the second qualitative phase of the study (Creswell, 2009) and researchers often use extreme cases, such as high and low scores on the dependent variable, as the selection criteria for the qualitative sample (Creswell, 2008). For this study, the selection of the phase two sample relied on the range of scores on the dependent variable from the first phase. The two phases of this study were connected in this manner; utilizing teachers' scores on the dependent variable from phase one to select the phase two case study sample. This sampling strategy was chosen to best realize the goal of the mixed-method study which was to understand and explain variation in science teachers' instructional practices. The six teachers selected for this qualitative analysis represent a range of implementation of reform-based teaching practices as reported on the SEC survey instrument, to better understand the complexities of the teacher socialization process for those who readily take up reform-based practices and for those who seldom implement these teaching practices. As previously indicated, the six case study teachers were selected based on their scores from the dependent variable of the

regression model, which indicated the level of teachers' reported use of reform-based teaching practices. As detailed in chapter three, these six teachers selected (two identified as implementing low levels of reform-based practices, two identified as implementing mean levels of reform-based practices, and two identified as implementing high levels of reform-based practices) were part of the quantitative sample of phase one and were also a part of the IMPPACT sub-sample or in-depth teachers (see table 9). Mark and Amanda were selected to reflect teachers whose scores were at the mean of the distribution. Alexander and Heidi were selected to represent teachers who reported low levels of reform-based teaching practices, while Matthew and Stephen were selected to represent teachers who reported high levels of reform-based teaching practices. Though the dependent variable was the sole quantitative measure used to select the phase two sample, the quantitative results from the first phase of this study largely guided the initial analysis of the qualitative data, using the statistically significant predictor variables as areas of qualitative focus within the three spheres of socialization. Themes presented in this chapter reflect these areas of focus as well as include topics of interest that emerged as influential to teachers' socialization not identified in the quantitative analysis.

### **Case Study Teacher Profiles**

The following descriptive profiles of each teacher were developed in order to familiarize the reader with these teachers, and to place each teacher in the context in which they were prepared to teach as well as the school context in which they taught during the IMPPACT study. The descriptive case profiles were partially developed by utilizing interview data and survey data. In addition, the teachers' self report of their school name on the NSTEPG facilitated the use of online school report cards to learn more about each teacher's school context. Table 14 presents summary information regarding each case study participant. The depth of the case descriptions

was somewhat limited due to the research design in which extant data were utilized for secondary analysis. All data that had been previously collected were de-identified, limiting what information was available about each case study teacher.

### **Teachers with Low Levels of Reform-based Practices**

#### **Alexander**

Alexander was a white male who was in his second year of teaching during the final year of data collection in 2009. After initially pursuing a business degree, he received a BS in Biology. Upon graduating from his undergraduate program he held several jobs, working in a neuro-rehabilitation center for adults with brain injuries, as well as in real estate. He left his job in real estate to pursue his certification in secondary science teaching at NCSU. He was enrolled in the program as a lateral entry teacher, an alternative path to receiving teacher certification in North Carolina. At the time of the study, he was teaching biology at a large urban high school in North Carolina, serving 2,540 students grades 9-12. In this school, 32% of the student population were eligible for free or reduced lunch. Alexander reported that the socioeconomic backgrounds of his students were lower than those of his own high school classmates. Alexander also reported the percentage of students of color in his classes was 75%, a higher percentage than that of his high school classmates. Alexander perceived his students to have low levels of academic motivation and average levels of achievement. As with other courses taught in North Carolina secondary schools such as English, Algebra I and II, Geometry, US History, Civics & Economics, Chemistry, Physical Science, and Physics, the biology course he taught had a state mandated end of grade/course test (EOC). Students must pass this EOC in order to pass the course. In his last year of teaching the school did not meet its expected growth target and did not make adequate yearly progress (AYP).

**Heidi**

Heidi was a white female in her second year of teaching during the time of this study. She received a BS in Chemistry from Syracuse University. After she completed her undergraduate work she immediately applied to the master's degree program in science education at SU, and received a MS in Secondary Science Education with certification to teach chemistry. During the semester after her graduation from her teacher preparation program, she worked as a long-term substitute before securing her position as a high school chemistry teacher at a suburban high school in New York, serving 1,603 students grades 9-12. At this school, 7% of the students were eligible for free or reduced lunch. According to Heidi's estimates, less than 10% of the students in her classes were students of color. In comparison to Heidi's own high school classmates, this is a higher percentage of students of color. However, she found the socioeconomic backgrounds of her students to be similar to the backgrounds of her high school classmates. Heidi reported the students in her classes to be of average academic motivation with average achievement levels. Similar to North Carolina, New York State requires end of course exams called Regents exams. Heidi's chemistry course did have a Regent's exam. At the time of the study her school was in good standing and made AYP.

**Teachers with Mean Levels of Reform-based Practices****Mark**

Mark was a white male in his third year of teaching during the time of the study. He graduated from his undergraduate study with a BS degree in Biochemistry. He pursued his secondary science teaching certification from NCSU, where he was enrolled in the program as a lateral entry teacher, an alternative path to receiving teacher certification in North Carolina. At the time of the study he was teaching Chemistry at a large urban high school in North Carolina

serving 2,238 students grades 9-12. Mark reported the students in his school had lower socioeconomic backgrounds than his own high school classmates, with 38% of the students eligible for free or reduced lunch. He also reported the percentage of students of color to be 50%, which was higher than the percentage of students of color among his high school classmates. Mark indicated that he perceived the academic achievement level of his students was low as was their level of academic motivation. His school was not in good standing and did not meet AYP during the time of this study. The Chemistry course he taught did have an EOC.

### **Amanda**

Amanda was a white female who was in her first year of teaching during the time of the study. Unlike the other case study teachers who received undergraduate degrees in a science field and then pursued their teaching credentials, Amanda received an undergraduate degree in secondary science education from NCSU and was certified to teach Biology. Upon graduation, she received her position teaching Biology at an urban high school in North Carolina serving 1,604 students in grades 9-12. Amanda reported the students in her school to have lower socioeconomic backgrounds than her own high school classmates, with 48% of the student population eligible for free or reduced lunch. She also reported the percentage of students of color in her school was 75%, which is higher than the percentage among her high school classmates. Amanda perceived the academic achievement level of her students to be low and the academic motivation to be very low. The biology course she taught did have an EOC. Her school was not in good standing and did not meet AYP during the time of the IMPACT study.

## **Teachers with High Levels of Reform-based Practices**

### **Matthew**

Matthew was a white male in his fourth year of teaching during the time of the IMPPACT study. He completed an undergraduate degree at Syracuse University in geology specializing in petroleum geology. After completing his undergraduate degree, he stayed on at SU to complete his master's degree in secondary science education becoming certified to teach geology. Matthew taught at a suburban high school in New York, serving 1,626 students in grades 9-12. At this school, 6% of the students were eligible for free or reduced lunch. Matthew indicated that the socioeconomic backgrounds of the students at this school were higher than that of his high school classmates. Matthew also reported less than 10% of the student body consisted of students of color, which is comparable to the percentage of his high school classmates. Matthew perceived his students had high academic achievement levels and had high levels of academic motivation. The course he taught had a Regents test at the end of the school year. At the time of this study, his district was in good standing and met AYP.

### **Stephen**

Stephen was a white male in his second year of teaching during the time of the study. He completed an undergraduate degree in Biology with a minor in Chemistry. He went on to pursue his secondary science teaching certification through a master's degree program in science education at UI. At the time of the data collection for this study, he was teaching at a suburban high school in Colorado, serving 1,059 students grades 9-12, of which 5.6% were eligible for free or reduced lunch. He indicated that the percentage of students of color was 20%, which was higher than his high school classmates. He perceived his students were of mixed academic achievement levels and high academic motivation. Though there were state exams for some

courses in CO, the courses he taught did not have an EOC. His high school was in good standing with overall high performance on standardized assessments of student learning. Stephen's school was an open enrollment school, meaning students could choose among many high schools in the district. Also, the organization of the school was different from a typical high school, in which the other case study teachers taught. Stephen's school was organized into academies related to specific learning interests. Students chose their academy and then took classes with a cohort of students enrolled in the same academy.



Table 14  
*Case Study Teacher Profiles*

Level of Practice	Name	Race	Teacher Prep	Years teaching	Highest degree	School setting	% of Students of color	Course taught	Grade Level	Student Achievement level
Low	Alexander	White	NCSU	2	Masters	Urban	75%	Biology	10th	Average achievement
	Heidi	White	SU	2	Masters	Suburban	< 10%	Chemistry	11th	Average achievement
Mean	Mark	White	NCSU	3	Masters	Urban	50 %	Chemistry	11th	low achievement
	Amanda	White	NCSU	1	Bachelors	Urban	75%	Biology	10th	Low achievement
High	Matthew	White	SU	4	Masters	Suburban	< 10%	Earth Science	9th	High achievement
	Stephen	White	UI	2	Masters	Suburban	20%	BioTech and Chemistry	11th	Mixed achievement

Note: Teacher Prep= University attended for teacher preparation,

### **Patterns of Talk about Practice**

Though the primary goal of the qualitative analysis of phase two was to examine the teachers' socialization experiences at different points and contexts during their teacher development, the initial qualitative analysis also revealed patterns of how teachers talk about their instructional practices. Two main patterns were identified: 1) how teachers explained their role as a teacher and 2) teachers' thoughts about reform-based pedagogy and descriptions about their use of these instructional practices. These patterns of talk about instructional practices are presented here first to help illuminate teachers' perceptions about their practice across the range of implementation of reform-based teaching.

#### **Perceptions of Role as a Teacher Associated with the Amount of Emphasis Teachers' Place on Authority and Control for the Learning Environment**

Throughout the interview data, these six teachers described their view of themselves as a teacher and how they perceived their role in the classroom. In cross case comparisons of these descriptions, what distinguished how teachers viewed themselves was the emphasis they put on control in the classroom, whether they assumed a more teacher-centered view of their role or a more student-centered perspective. Four of the teachers, Alexander, Heidi, Mark, and Amanda, described ideas and practices aligned with a view of themselves as a teacher in control, placing an emphasis on maintaining authority and responsibility for the classroom environment and student learning. Alexander and Heidi both described their science teacher role as a "facilitator." Though they used this term regarding student-centered teaching, they still tended to talk about practice in ways that didn't emulate a facilitator's actions. Alexander stressed that he ideally doesn't want to be the center of focus in the classroom, and that he wanted to "get out of the way and really set up an environment where they can do their thing, and I'm not involved" (Beliefs

Interview, 2008). This view of himself as a “facilitator” of classroom learning is one in which he describes his ideal self as a teacher, a role for which he has not yet attained. In describing this he stated:

If I could find a way to get them moving, where I’m not the center of focus. I don’t need to lecture. I can lecture them daily...But, um, and I...But, they won’t get anything out of it, I don’t think. And, I want them...to engage and...run with the activities. So, my job is to try and figure out how to engage them and motivate them. (Beliefs Interview, 2008)

Alexander’s descriptions of what he would like to be able to do; to get them moving, and not lecture daily, to engage his students, was expressed as what he hopes to achieve in the future, but was not present in his actions. He commented that his lack of organizational skills and abilities to adequately evaluate activities to see how they fit well with learning objectives hindered his ability to follow through with his role as facilitator. In fact when first asked about his role he stated, “My role as a teacher. Sure heck if I know” (Beliefs Interview, 2008). Though he wanted to be a facilitator he was not able to envision what this meant for his practice in the classroom.

Heidi also described her role as a facilitator, but did not elaborate on how her actions in the classroom were indicative of this. Instead she struggled to put into words exactly what it meant to be a facilitator. When asked to describe her role she stated:

Um, that’s a hard one.... Um, facilitator. Like, I try – I mean, I tell them what they mean, but then - I’m not like a preacher to them for the most part. Like, um, I, like, explain how to do it as simply as I possibly can, but then I really try and let them work it out. Like, I – like on the thing today, I was, like, all right, well, we’re going to do this. And I knew that

a lot of kids weren't necessarily going to know what to do right off the bat, but I felt like I didn't know – I couldn't have said something else to make it better, like, they had to try it first. (Beliefs Interview, 2008)

Heidi's comments about her role suggest a tendency toward an authoritative teacher-centered role in her approach to instruction and student learning, despite her willingness to let them "try it first." A teacher's role as facilitator also comes up in Mark's view of himself as a teacher. However, unlike Alexander and Heidi, Mark was not sure he believed achieving a role of facilitator was possible in the classroom. In his comments regarding his role as teacher he noted:

It...I would love to believe my role is to facilitate! I'm sure that's the answer that... But, sometimes I do have to do, kind of, direct instruction...where I'm not just facilitating, but I'm, "This is what you've got to do." And uh...as much as I'd like to say, "Oh, my kids! I just ask them a question, and they can run with it!" It doesn't always work that way. In reality. (Beliefs Interview, 2008)

For Mark, though he seemed to have an idea from his preservice teacher preparation about what he ought to believe about his role as teacher, he did not see this as applicable in the real world of his classroom.

Amanda's view of her role as teacher was slightly askew from the previous three teachers, although still teacher-centered in nature. Her first reaction was to think of herself as a "babysitter" stating, "I want to say babysitter, but, that is part of it! It's just teaching them how to behave with each other" (Beliefs Interview, 2008). Throughout Amanda's discussion of her teaching, she focused on the need to conquer her ability to be an effective classroom manager. As a first year teacher, right out of her undergraduate, she feared that her age and her small

stature made it more difficult for her to get a handle on taking charge of the classroom. She reflected this when she expressed, “That’s been hard for my first semester too. They thought they were on my level and I always had a hard time adjusting to being above, but not too much” (RoPPE Interview, 2008). This struggle for her to move beyond feeling like a “babysitter” impacted her ability to implement certain practices in her classroom. Early in her first year of teaching she described trying to do things that were fun and “out of the box” such as taking her students outside for an ecological game, but her struggles with managing students effectively led her to view the need for more control in the classroom and to continually adjust her expectations about what she could accomplish. She described here a sense of still struggling to figure out what worked when stating:

I feel like I’m still in that phase where I’m just figuring everything out. So. You know? Figuring out what I want to have happen, and how to get it that way. It’s one of the things you don’t—you can think about it all you want. But, until you’re live with the kids, it doesn’t really hit. You know. Like, you can think, “Oh, I want the kids to do this with a paper.” But, if you can’t get 30 kids to do that, then, you’ve got to try something else. So. It’s a lot of adjusting, thinking on your toes kind of thing. (Beliefs Interview, 2008)

The noted tone of authority and control for the learning environment in these four teachers’ descriptions of their roles as teachers was absent from Matthew and Stephen’s descriptions about how they viewed themselves as teachers. It wasn’t that they didn’t assume some level of classroom control, but rather their approach to teaching was more collaborative and student-centered. Stephen also identified his teacher role as a “facilitator.” He stated, “I think mostly as a facilitator I can’t make them learn. I can’t punch a hole in their head and stick it in there. I have

to make it accessible and understandable, and I have to help them learn it as best as possible” (Beliefs Interview, 2008). Stephens’s description of a facilitator does not assume all responsibility for student learning, he alone does not have the authority to make learning happen. Stephen viewed his role as a science teacher going beyond just teaching the facts and information about chemistry or biotechnology. Part of his vision of acting as a facilitator incorporated a view of what his purpose was as a science teacher, to educate students so they would be able to make rational decisions as future voting citizens. He reflected this when he noted:

You know, we’re not here to teach the information, we’re here to teach the skills, they’ll learn the information some point later if it’s important, otherwise, they will forget the information, but hopefully they will learn the skills that went along with it. So that was a paradigm shift and I think a good one. It let me not be mad if we don’t cover a certain thing. Just because we should have confidence that if presented with that material at some point in their life they will have the knowledge and skills to do it. (RoPPE Interview)

Stephen further refined his role as facilitator also identifying himself, as a “collaborative investigator.” He enacted this vision by creating a collaborative environment with the students where his instructional approach was to set the stage for students to be involved in guiding their learning. He described this stating:

I make sure that I’m not the pure authority, I of course, introduce the topics to them and I may say the first couple of things, but I’ve built enough rapport and comfort in the class where they will just raise their hand and say, hey I watch this yesterday or they will come up to me with this, and hey we read this in another class and I thought you would like it.

Then they kind of start guiding themselves and you end up making almost a collaborative environment where if you tell them honestly that I really don't know how that works that's a really complicated things I'll have to look that up. Sometimes they will come in and have already looked it up for you and so they get that desire to learn and they are interested in the topic and so they kind of take over from there. (Beliefs Interview, 2008)

Matthew's view of his role as a teacher also portrayed his desire to function more in a guiding capacity and less of an authoritarian capacity. He defined his role as a "reference person" stating:

"Um, my role here is to be a person that has had a lot of experience and who has gone through these things before. So I'm here as a reference person, to guide them through mistakes that I know they'll make, and, um, I'm here as a person, aah, for questions and answers. And then I'm here to help them succeed. (Beliefs Interview, 2008)

Matthew wanted to get students excited about coming to class and getting involved in their own learning. He saw his own background and past experiences as providing him a strong base from which to help guide students.

### **Practices for an "Ideal World"**

Teachers' thoughts on reform-based pedagogy and the nature of how they did/did not incorporate these types of instructional practices varied along the same lines as their views on their roles as teachers. Alexander, Heidi, Mark, and Amanda were very general in their descriptions of instructional practices related to reform-based pedagogy. Often ideas presented about teaching were broad in nature making it hard to discern their level of understanding about, and use of, reform-based teaching. Teachers used words like "inquiry or "hands-on" to

summarize practices they deemed reform-based in nature. Amanda demonstrated this when she commented:

So, ideally, I would probably do some inquiry thing. I would really like to do more inquiry, where they're figuring out something, hands-on working through a problem. And then to go over what the details are of it, maybe, give some notes or something, and then, do some practice with it, maybe another lab, or a worksheet, or some group work or project or something. (Beliefs Interview, 2008)

More than just a very general description of reform-based instructional practices, these teachers also conveyed an inability to implement them or that these kinds of practices were only valid in an "ideal world." Alexander expressed his dissatisfaction with his teacher-centered approach and lack of implementation of the kinds of instructional practices learned from his preservice teacher preparation. He commented, "But, teaching us those sort of things I think were fine and were very valuable. I just don't know how to pull them off here quite yet" (RoPPE Interview). He also stated, "like, how the heck do you teach mitosis and meiosis because they don't get it. You try these different things. They still don't get it. And how do you make it interesting and fun" (RoPPE Interview). In both of these comments, Alexander expressed his frustration with not being able to implement the kinds of practices that he believed to be valuable and engaging. Mark often discussed the "ideal world" of preservice teacher education and how the practices learned there, while valid, did not functionally have a place in the real classroom. When asked about this he stated:

I was just like there is no way you can convince me that my kids would even remotely go along with some of that stuff. It was – things like projects or inquiry learning – not that I



disagree fundamentally with it but it's just I think things have changed and one of the things that they can do is put the professors back in the classroom for a little bit.

(Preservice Interview)

The views expressed by these teachers stand in stark contrast to Matthew and Stephen's descriptions of instructional practices. Both of these teachers explained in detail how reform-based instructional practices were evident in their practice without any mention of the "ideal world." Matthew described how his instruction utilized the learning cycle, an instructional model he learned in his preservice program. He began his learning cycle lessons with "anticipatory introductions to set the stage for the learning cycle" such as shooting sparks of color demonstrations, or petroglyph activities (RoPPE Interview). Matthew also expressed the importance of finding ways during his instruction to make science relevant to students' lives. He stated, "So I incorporate those to keep them motivated to share stories and to help them learn about things that we're learning about in class to make it relevant to them" (RoPPE Interview).

Stephen, even more so than Matthew, clearly articulated how his actual classroom practices mirror the principles of reform-based instruction. Stephen described how "inquiry basically the whole construct, you know, learners construct their own understanding has kind of become my philosophy or belief" (RoPPE Interview), and has served as the foundation for how he approached his instruction. Throughout his description of instruction Stephen discussed such things such as: (a) he modified existing labs that were not suitable for open inquiry, (b) emphasized the importance of questioning strategies, (c) described how and when to incorporate direct instruction techniques when necessary as a part of an instructional model, (d) structured a course to focus on teaching interrelationships between concepts, (e) made science relevant to students, and (f) used performance assessments to determine student understanding. Stephen

also described his focus on curriculum development was driven by what order would be best for students to build understanding. A common theme to his descriptions was a focus on the student.

Stephen stated:

Also, looking at the subject matter from a different perspective, more at the level of the learner, what previous experience do they have to draw on, how can I use analogies when I teach this, how can I relate it to the real world. Rather than teaching it in a little bubble of just inside this cell which has not immediate relevance and they don't care about.

(RoPPE Interview)

Stephen and Matthew's descriptions of teaching, which focus on the learner and their need to be involved in the learning process, sets them apart from the other four teachers who are less descriptive of their teaching practices and in general feel in some way they were not able to realize instructional practices learned in their teacher preparation that may only work in an "ideal world". Though it appeared Alexander, Heidi, Mark, and Amanda at some level philosophically agreed with aspects of reform-based pedagogy, they were not able to adequately explain these practices nor were they able to implement them in their practice.

The patterns in the interview data regarding teachers' description of practice parallel the findings from the phase one SEC survey data. In cross-case comparison of these descriptions, Matthew and Stephen, both teachers with high levels of reform-based teaching practices, discussed their practice in distinctly different ways than the other four teachers. Though the original analysis intended to explain the differences between three groups, low, mean, and high implementers of reform-based instructional practices, what emerged was really a comparison of two groups. Throughout the data analysis the teachers with low and mean levels of reform-based

teaching practices were found to be more similar than not in their descriptions of practice as well as the descriptions of their experiences that influenced their practice. In analyzing the data, it was often hard to distinguish themes that separated the mean teachers from the low teachers. The rest of the findings of this chapter reflect this dichotomy in the data, seeking to explain how and why only two of these six graduates of reform-oriented teacher preparation programs went on to implement the kinds of instructional practices emphasized during their science teacher preparation.

As with phase one, teacher socialization served as the theoretical frame for this part of the study guiding the analysis to look at key individuals and experiences in the teacher socialization process in conjunction with the various learning to teach contexts to better understand and explain how these factors interact to shape the kinds of instructional practices teachers chose to use in the classroom. The themes presented are related to the significant findings from the quantitative phase of the study as well as other factors that emerged from the data. The findings presented here are organized according to three main spheres along the continuum of teacher development that research has identified as influential to the socialization of teachers and their developing instructional practices; (a) teachers' backgrounds, (b) local contexts, and (c) state policy environments (Achinstein, Ogawa, & Speiglmán, 2004).

## **Teachers' Backgrounds**

### **Personal Backgrounds**

#### **College science coursework experiences similar for teachers across all levels of reform-based teaching practice.**

The typical experience as a student in a college science course was very similar among the six teachers in this study. The formats of most courses were generally lecture and

PowerPoint based with students taking notes on content. Heidi depicted this when she stated: “Um, well in college, it’s always like you come in, you sit, you listen and you leave. You take your notes, you don’t say anything. You don’t really do anything and then you’re expected to produce” (Preservice Interview). Other teachers also described the passive nature of their learning in their college science courses. Though there were some descriptions of opportunities for partner problem solving or group research projects outside of class, cooperative learning opportunities were negligible outside of lab group work. The main focus of these courses was on content, not skill development as Mark described, “At the undergraduate college level it is content, content, content, content, content. There is very little in skills” (Preservice Interview). Students felt a great deal of their time was spent reading textbooks, answering questions from assigned readings, and memorizing information. Stephen also described how this structure forced students to focus mainly on keeping up with content acquisition. He explained:

Undergrad work, it was kind of one of those things where you just had to read a chapter a night and then they threw a power point at you; then repeat the information. If you got behind on the reading, you were kind of screwed until you got caught up or you wouldn’t be with it and then there would be a couple of weeks of lecture and lab portions built into every biology and chemistry class. (Preservice Interview)

This focus on content memorization was also inherent in the lab experiences associated with science courses. Amanda discussed lab experiences in which she did not feel like she really learned anything. She described one lab in which she was given “20 organisms . . . And, you had to know, like, at least six things on every one. And, that was what your lab day was like . . . just writing down and memorizing the stuff” (Preservice Interview). These six teachers also noted

their learning was primarily assessed through multiple-choice tests with some short answer questions and lab reports/questions.

**The quantity and quality of teachers' scientific research experiences associated with teachers' level of practice.**

The amount and type of scientific research experiences varied greatly among these six teachers. While all the teachers discussed having some research or lab exposure in their undergraduate science coursework, the degree to which they participated in these experiences varied depending on their level of practice. Teachers who reported low or mean levels of reform-based instructional practices indicated they had little to no scientific research experiences beyond the scope of what was required for their coursework or degree program. Two of these teachers, Alexander and Amanda, only had laboratory experience that was directly related to their coursework. Neither of these teachers ever worked in a laboratory setting, or on a research project apart from laboratory courses. Heidi described participating in research for a specific research course that was a part of her degree requirements. She was required to pick a professor and work with them on their research. Though she described working in this setting for three semesters, she did not feel very engaged in the research project, and often was given low-level tasks to aid the researchers. She commented:

So I like picked a professor and we did stuff. I wasn't always the most involved in it because of the way it all kind of worked, like 'cause I was low man on the totem pole. So I didn't always even know what I was doing, like I was in there and I was putting together like glass tubing, but I didn't really like know everything that was going on.

(Preservice Interview)

Mark also had a similar experience to Heidi in that he worked in a research laboratory at his college as a part of an independent research course that was optional for his major. Mark thought this was a positive experience for him commenting, “It gave me a good understanding of how a lab works in general, what the process is and how sometimes – how slow and cumbersome it can be. But I understand why it’s there” (Preservice Interview). However, Mark did not specify his level of participation or any specific skills he gained while completing this research course.

Unlike these four teachers, Matthew and Stephen discussed extensive research experiences that fell outside the normal requirements of their degree program. Both teachers sought out opportunities to participate in laboratory or field research experiences beyond what was available through coursework or degree requirements. Matthew felt he had a great deal of research experiences in his undergraduate program, more so than his peers. He sought out these research experiences by emailing professors describing his desire to do some extra work. Matthew selected one of the professors who wrote back and continued to work with him for the last three years of his undergraduate degree. Throughout this work Matthew felt integrated into the work of the project stating, “I kind of become one of their members of their research team” (Preservice Interview), and worked collaboratively as a part of this five-member research team. This integration meant he was invited to use all their resources such as their computer and equipment room, worked weekly on data analysis and interpretation, and was invited to join the team on a research trip to Africa over the summer. These research experiences were significant for Matthew in that he felt he learned a great deal about the practices and processes of scientific research. Matthew commented:

I, uh, learned, uh, how to prepare, or um, come up with the research project questions. And then I had to learn how to go about answering them through labs, uh, field experiences. Field excursions, how to prepare then once, you know, the actual collection of data. How to do that. And then how to make the interpretations of the data back in the, in the lab. Um, and the um, presentation. We did presentations skills and things like that. So, That was helpful. (Preservice Interview)

He also felt that beyond learning these specific research skills, he also learned how to interact and work with other scientists. Matthew valued his research trip to Africa especially, “because it was not just a science trip it was like a social experience. Lots of social experiences. And, uh, working with colleagues in different parts of the country, not just doing lab activities” (Preservice Interview).

Stephen also shared details about extensive research experiences from both his undergraduate degree program and from working in other research settings. During his undergraduate studies, Stephen described having a lot of independent research opportunities in some of his courses. These experiences permitted him freedom to work with a lab partner to design and implement his own research studies. Stephen stated:

So then we started thinking of our own research projects and then doing those and collecting all the data and doing all of that our fourth semester and every subsequent semester. We were in a lab starting from day one learning all the tools and resources and later using them for our own. We had access to some pretty neat stuff as far as, everybody would be able to use an NMR machine, walk in and take our own NMR (Nuclear Magnetic Resonance), bond energy so you can figure out the contribution of

your chemicals are. We had one that we could use and had access to neat stuff like that.

(Preservice Interview)

Not only did he have access to many resources to use in his research, he also had opportunities to present his research to the class and to the science department. He valued these experiences as they prepared him to be able to “write a concise presentation” of his research. However, some of Stephen’s most significant research experiences were not at his undergraduate university. He also worked in a genetics laboratory during the time between his senior year of high school and freshman year of college. He described gaining laboratory skills such as “staining and microscope work and some imaging and things like that before I really knew that much about it, so that got my nose into it” (Preservice Interview). Later he spent time working in a Boston laboratory with a post doctoral fellow on his research. He valued this experience because he felt like he was a small, but important, part of the research. He stated, “I was one little part but it was cool knowing that I found something cool a really efficient way of doing something, it would be used down the road” (Preservice Interview).

At the time of the IMPPACT study, Stephen was still pursuing research opportunities and worked in a genetics lab in addition to his teaching responsibilities. In describing his reasons for taking on this research work he stated:

It gives me an opportunity to keep in the field and keep active knowing what happened yesterday instead of three years ago when I was taking genetics courses. Hopefully I can continue to do that in the future and build connections and have a class when I want them to genotype things I will have the resources. To be able to use the contacts to genotype a class instead of strawberries, it is better for the students. (Preservice Interview)



These experiences as well as the opportunities that Stephen and Matthew both had prior to pursuing the teaching profession provided them with the occasion to develop the skills and processes of science as well as time spent interacting and discussing research with other scientists. These formative experiences for Stephen and Matthew socialized them into the scientific profession in a way that the other teachers did not experience. These kinds of opportunities were either not available or not sought out by the other four teachers.

**Teachers' best and worst experiences as a science student shaped visions of good teaching regardless if these visions were enacted.**

All six teachers recalled an experience as a student with a science teacher that they really enjoyed and impacted their interest in science and/or science teaching. For some it was their teacher's personality that they enjoyed. The best teachers were described as "so much fun" or "charismatic"; they were "personable" and "sociable" and treated students with respect. Teachers such as these created fun and inviting classrooms with their own personal style. Beyond the teachers' personality, it was the experiences they created and their pedagogy, which stood out as most influential and set these best teachers apart from other teaching experiences as students. Two teachers recalled their high school chemistry teachers' pedagogy as influential to them as students and later as teachers themselves. Amanda described that her high school chemistry teacher "did more college based things, guided more than telling. He just let us make up our own, and guided us more than telling us how to do everything. I guess I learned a lot by just playing around with stuff" (Introductory Interview). Amanda felt that in the early teaching experiences of her preservice teacher preparation she tried to mimic his teaching style. Heidi also felt strongly influenced by her high school chemistry teacher, crediting her with the reason to pursue chemistry. Heidi described her as:

“part of the reason why I wanted to become a teacher too, because she was such a, she was a really cool lady, like she came up with all this different stuff. I loved watching, um, she like we would always have demo days and we would get really excited about those where, um, she’d do tons of stuff and it was just really cool to see that, um, chemistry was really...once I hit that teacher, I like loved it and I was like totally into chemistry and I was like I want to be a chemist, like in high school I said that I wanted to major in chemistry and everything. So, she was, that’s probably one of the most memorable points because it changed a lot of what I wanted to do. (Introductory Interview)

The other teachers’ best experiences as a science student came during their college career.

Alexander expressed that the chemistry professor at his community college created a classroom where for the first time “he experienced a lot of success as a student” (Introductory Interview).

Like Amanda and Heidi’s high school experiences, it was the pedagogical style of the professors that made these experiences so memorable. Mark commented that his developmental neurobiology professor was not the norm, which is what made neurobiology such a great class.

He stated:

The professor was opposed to teaching in what I call the normal mode which is lecturing from notes and writing on the board and copying down...we did more of a seminar kind of thing where we actually had to read actual journal articles on neuro research. I mean there were times when she was filling in background for us but once she filled in the background, then we were expected to read these journals and process that information. (Preservice Interview)

Mark valued the different approach to teaching science in this course, as well as being pushed to process information beyond the typical rote memorization of the majority of his college science courses. Stephen echoed this in his view of his biochemistry professor. Stephen felt she held students accountable, taught you how to study, made things applicable and involved students in conducting and presenting research. Throughout this course Stephen felt that as a student “you really had to step outside the box and think how does this equation we looked at and the properties of this relate to the real world” (Preservice Interview).

Many of the teachers tried to incorporate attributes of their “best” teachers into the vision of how they saw themselves as teachers. Some of these “best” teacher attributes became central to their vision of good teaching, even if they did not enact these visions. In general teachers wanted to be just like their good teacher. Heidi described wanting to “emulate the way that she taught, she was a really good teacher” (Introductory Interview). Alexander wanted to have the same kind of impact on his students that his greatest teacher had on him. He commented about a lesson he took away from this teacher that became central to his vision of teaching, “So, I think that, on one level, as a teacher, I’m trying to be very open to the idea that I can make an impact in some of my students’ lives” (Introductory Interview). Matthew’s vision for his teaching practice incorporated wanting to “follow in his footsteps,” and to “follow what he was doing and add my own style, too” (Introductory Interview). Mark talked about how he used some of his best teacher’s strategies in his own teaching. He stated:

A lot of the ways she taught are kind of the same ways that I bring – or what I try to bring to the classroom also. And a lot of the techniques she used and things like that are what I try to do with the students here...Just the...with the laboratory, trying to get the students

to be formalized in their laboratory approach yet still give them a chance to do some inquiry type laboratory work. (Introductory Interview)

The visions of good teaching derived from these experiences as students were what many of these teachers strived for in their teaching. They wanted their students to feel like they did when they were in these classes and be as excited to learn science as they once were. For most of the low to mean level of practice teachers, aspects of their visions of good teaching are not realized in their descriptions of their own teaching.

Though these positive experiences resonated with these six teachers and helped them to envision the kind of teacher they themselves wanted to become, these experiences were rare. This “type” of teacher, one whose personality and pedagogy came together to create a unique learning environment where students felt engaged and involved in their learning, was not the norm of their experiences. All six teachers had many examples of the “bad” teaching experiences to share. These negative experiences also helped them to envision the kinds of teachers they did not want to become. The teachers in this study had many shared experiences regarding the qualities of the worst kind of teaching they had experienced. The composite portrait of this “bad” teacher is one that was unprepared, may have lacked content knowledge, and did not have personal relationship skills or interact with students well. The less appealing pedagogical practices used by this “bad” teacher were primarily lecture and note taking based instruction, focused on memorization, and moved through content material too fast leaving students feeling lost. The six teachers expressed feeling bored, frustrated, getting headaches, and frankly not learning very much during these types of class experiences as a student.

These negative experiences as a student aided many teachers to develop a vision of the antithesis of what it means to be an effective teacher, learning what not to do. Heidi described what she learned from such an experience:

I don't want to be like her if I'm a teacher but I think if anything it says to me what not to do. Like don't be that teacher where you aren't learning, where the students aren't learning. It was frustrating for me, I didn't like feeling lost all the time, as a student. And so for me as a teacher I have to recognize that my students don't want to feel lost either and so explaining things as best you can, giving them the opportunity to explore things on their own, um, having a productive learning environment is what I got out of her lack of that. (Introductory Interview)

Heidi did not want to be a teacher whose instruction did not allow students to explore things and feel engaged in their learning. Other teachers expressed similar sentiments, stating that they wanted to create productive learning environments unlike the ones they had experienced. They wanted to stay innovative in their teaching unlike many of the “worst” teachers they experienced having. Stephen focused on this when he discussed what he took away from one of these experiences:

This other guy really didn't make you want to learn it, he made you want to fall asleep. That's what I think of when you're going to find teaching in front of people, I think, am I being dull and monotonous, am I making them not like this stuff because they relate it to me at this moment and maybe I need to portray it in a different light, more fun and exciting, things like that. (Preservice Interview)

Stephen felt it was important that he, “try not to do that, trying not to get into a redundant hole and using worn out presentation and try to give myself a chance to do it right” (Introductory Interview). That is what most of these teachers took away from the negative experiences, an idea of what not to do, or as Stephen expressed “a chance to do it right.”

### **Professional Backgrounds**

As previously indicated, the six teachers in this study were graduates of three reform-oriented teacher preparation programs, UI, SU, and NCSU. The IMPPACT research study purposefully chose these three universities for several reasons: (a) they were similar size doctoral-granting institutions, (b) they were located in different geographic regions of the country, and (c) they shared similar characteristics and preservice program features. Though each of these programs featured multiple science methods courses, required extensive science content coursework, and required multiple field placements, there were several differences among the programs. While all three schools featured a focus on the nature of science during teacher preparation, only UI and SU offered a stand-alone required course, with UI requiring two classes in the nature of science. UI also offered coursework in the applications of science, which were not offered at the other universities. The UI and SU programs formed preservice teachers into purposeful cohorts, engaging in the preservice teacher education program together throughout its entirety. Perhaps one of the greatest differences among the teacher preparation programs was the amount of time (hours) spent in field experiences as well as the nature of preservice teachers’ activities during these placements. Table 15 presents the total number of placements and hours spent in the field during these placements. Preservice teachers in UI spent the most amount of time in field placements, more than double the preservice teachers from NCSU. In addition to spending less time in the field, preservice teachers from SU and NCSU

spent more time simply observing classrooms than the UI teachers did. It should be noted, that discussion of the characteristics of these three programs only relates to the structure of the programs during the time of the IMPPACT Project.

Table 15  
*Field Placement Requirements by University (# of hours)*

University	Placement 1	Placement 2	Placement 3	Placement 4	Student Teaching	Total Hours
University of Iowa (UI)	60	75	135		450	720
Syracuse University (SU)	25*	25*	120	40**	330	540
North Carolina State University (NCSU)	20*	22.5			300	342.5

Note. \* indicates time spent only in observation \*\* indicates time spent tutoring in small groups or one-on-one

### **Teachers found common ground in their descriptions of the science specific methods courses.**

These six teachers generally agreed upon several features of their preservice teacher preparation that they enjoyed and found valuable to them during their process of learning to teach. All three programs featured science content-specific methods courses. The teachers expressed being pleased with these courses and found them useful, unlike the “foundation” education courses they were required to take. Matthew’s comments represented this when he stated, “my methods courses were my favorite ones, because it was actually instead of just general teaching philosophy it-they helped us, um, think about how we would teach science or a particular subject” (RoPPE Interview). Though the above descriptions of the three teacher preparation programs outline several key structural differences, the guiding philosophy of the programs were similar. Due to this similar guiding framework, the six teachers shared many

common experiences throughout methods courses. Teachers discussed experiencing a great deal of modeling how to teach, often participating in lessons as a student while the professor modeled how to effectively use reform-based instructional models. Heidi described how her methods professor would:

model a certain, like, activity that we could do. And then we'd see, like, wow, this is really good, this is a good thing that we can do. Like, now I want to try that. So, I think, um, his modeling in the course was a big influence as to what I thought. (RoPPE Interview)

Several of the Biology teachers commented that the instructional modeling was heavily biased towards the physical sciences, but still found these learning experiences useful. Beyond playing the role of the student, all six teachers also described having micro-teaching experiences where they would often plan and instruct a lesson individually, or in small peer teams, and then received feedback. All teachers also discussed a big focus on unit and lesson planning using learning standards throughout their teacher preparation. Much different than their content preparation, these six teachers all experienced a great deal of time engaged in cooperative group work in their science methods courses. The teachers found this work valuable, and the interaction with their peers to be a contribution to their teacher development, particularly among those who were members of purposeful cohort groups. Finally, all six teachers described having good relationships with the methods faculty, which was not always the case with the other education faculty in their programs. They found the science methods faculty to be “open” and “personable” and having a lot of knowledge and experience. Amanda represented the sentiments of these teachers with regards to the science methods faculty stating they were:



Just, very open to, I want to make you the best student and the best teacher I can, instead of the other classes, where . . . the other science classes . . . where it's, I'm just teaching you. You do what you want to do, and this is just up to you, type of thing, where it's more hands-off. (Preservice Interview)

**Teachers' perceived quality of their teacher preparation linked to amount of practice in the field.**

Despite these teachers sharing and finding value in several common experiences during their preservice preparation, the discourse about the overall quality of the program differed among the graduates of the three universities represented in this study. These differences in perceptions of program quality were linked to discussions of the structure and duration of the field practicum experiences, which was highly variable among the three programs. As previously noted, Table 15 highlights the number and duration of field experiences across the three teacher preparation programs represented in this study. Stephen, a graduate of UI, experienced the most field practicum hours, a total of 720 hours across three early field placements and his full time student teaching placement. In all of these experiences he participated in teaching some of the lessons, rather than acting only as an observer. Unique to the UI field practicum experience was the inclusion of field placements across elementary, middle, and high school levels. Heidi and Matthew, both graduates of the SU program, experienced 540 total hours of practicum experience across four placements and their full time student teaching. The two initial placements were spent observing a science class, while the fourth placement was a tutoring placement focused on student literacy, where preservice teachers worked one-on-one or with small groups of students. Their third placement was their

“candidacy” student teaching placement in which they were in the field teaching for half the school day. The SU program strived to provide their preservice teachers with a diverse set of field experiences, placing them in both suburban and high needs urban/rural settings. Finally, Alexander, Mark, and Amanda were graduates of the NCSU program. At the time of the study, NCSU had the lowest amount of field placement hours, a total of 342.5 across three placements. While the first placement was only for observation, preservice teachers took more teaching responsibilities in the other two placements.

Along with this disparity in total field placement hours, came a difference of opinion of the overall quality of the preparation program among program graduates. Heidi, Matthew, and Stephen were pleased with their teacher preparation program quality. They were particularly satisfied with the practice they had in the process of learning to teach commenting favorably on both the structure and length of their field experiences, Matthew felt that his field experiences were among the best experiences he had in teacher preparation. He stated:

...field experiences gave me, um, an actual sense of what to expect and how those research-based, ah, teaching practices and ideas would actually play out with real people and real students. Um, I feel that in my own field experiences, the more I did, the more effective those field placements were for me. (RoPPE Interview)

Matthew found them beneficial in terms of the wide range of experiences with student populations, school cultures, range of student abilities and types of teachers he interacted with. Similarly, Heidi also found the SU field placements to be valuable. She stated:

And, um, it was really good how much time we spent student teaching. Um, and I really like the way that it was broken up. We had like a part time student teaching in the spring

and then we did our full time student teaching in the fall. I think that's way better than what other schools are doing, where they have like the two placements back-to-back, and they're -- each one is shorter. Um, I had wonderful student teaching experiences. And, like, they were so much better than what everybody else, like, what so many other people go through that I think that made a world of difference for me. So, I don't -- I don't know what there could be improved on, because when I talk to everybody else, they had such a worst time. Like, I don't know, like, I don't know what could be better. (RoPPE Interview)

Stephen echoed Heidi's opinion of the value of the field practicum structure when he described UI's approach to field experience. Stephen expressed the progression of elementary, middle, and high school placements enabled him to build more confidence in himself as a teacher. He stated, "I also like all the time spent teaching and being with students and designing the class because I'm not naturally good in front of people as far as presenting and things like that or talking or teaching" (Preservice Interview). Stephen viewed this progression across the various student grade levels as having helped him to learn developmentally where all students were, how far you could push them, how much you could let them do on their own, and the depth of questions to ask across grade levels. He found that it also changed his focus on learning about teaching. He stated:

Then when you get more old habit, you would be paying more attention to what you're teaching rather than how you're teaching and you're not so worried about the dry look, you're more into trying to get your questions answered and stuff like that. The progression is to give you more in class experience which is beneficial, but knowing where they are at all points in their education. (Preservice Interview)

After gaining his confidence in his earlier elementary placements, he felt ready to focus on the substance of his teaching. He found that the time to gain confidence and practice was essential to his learning to how to teach effectively. Stephen commented that he “couldn’t imagine if I would have had only four or six weeks student teaching and that was my only experience and if I got thrown into that, that would have been tough for me” (Preservice Interview).

Though generally pleased with several aspects of their preparation, the graduates of NCSU had a much different discourse about the nature of their preparation, specifically related to their field experiences. Throughout the initial coding of data, an early theme related to negative aspects of teacher preparation was dominated by comments from Alexander, Mark, and Amanda. Alexander reflected this in his statement that although he thought his preservice preparation was a great introduction, it eventually fell short because as he stated, “But then, it didn’t . . . as far as . . . I guess it didn’t give me as much structure in my actual classroom, when I was let go . . . as I would have wanted” (Preservice Interview). This notion that something was missing from his preparation, or it didn’t provide him the structure he needed, is rooted in the kinds and amount of practice NCSU program graduates were afforded. One area of their preparation these three teachers believed needed improvement was having more time early in their preparation actually teaching and interacting with students. Amanda commented, “I think that would have helped. You know? At least practicing in front of the students, instead of just in front of my peers” (Preservice Interview). Not only was it the lack of time spent with students in the field, but she also believed the early field experiences, in which preservice teachers primarily observed in science classrooms needed improvement as well. She stated:

I think if we did a field experience where you had to get in there. Not, “I can just sit in the back of the class and observe, and I’ll get my grade for it.” I think if you had to work

one-on-one with a student, or if you had a group of students that you had to teach that lesson to . . . or something like that . . . where it would give you more practical experience. (Preservice Interview)

This need for more practical experience is echoed repeatedly in Amanda's sentiments about her preparation. She expressed that prior to her full time student teaching, she felt she had an insufficient amount of experience actually designing and implementing her own laboratory or activity. She had wished her early field work had required her to "try it before you get into that student teaching experience where you're expected to do it every single day, yeah, that would have been good" (RoPPE Interview). Beyond this, she felt that her preparation did not provide her with "enough practice changing stuff around" for students who were not getting the material through lectures. She did not feel the practice she had gave her the ability to "change the material to get the content across" from college to high school or middle school levels (Preservice Interview).

Mark also found the field experiences during his teacher preparation to be inadequate. Specifically he felt what was needed was "much more contact time. I mean, it's, as much contact time as possible. And, as much responsibility for those students that are getting the contact time" (RoPPE Interview). Throughout Mark's interview comments, he frequently critiques the lack of time spent in the classroom practicing teaching. He found the program's structure to be "ridiculous" and "horrible" that there were so few weeks of student teaching with only two other minor placements. For Mark and the other NCSU graduates, this lack of time in the field during their preservice preparation manifested itself as a feeling that what they were learning in their teacher preparation was not very useful. In regards to his experiences in the field, Mark stated, "in general when you teach your class, is not practical" (Preservice Interview). Mark described

he learned what he needed from his preservice preparation only after he had started in his own classroom. He wished his preparation had provided him with more concrete experiences to prepare him for the reality of the classroom. He stated:

The focus on real life situations. I guess that's the nicest – well not the nicest but that's probably the best way to put it is that once you hit the classroom, there are so many other issues going on that a lot of what – you have to wrap your head around those issues first before you can even start to try to implement what they teach you in the teacher education courses. (Preservice Interview)

With very little time spent in the field prior to becoming a full time teacher, Mark and the other NCSU graduates felt they were still figuring out the basics of running a classroom rather than focusing on effective pedagogy.

**Modeling practices after lessons learned from host teachers are either focused on procedural or pedagogical aspects of teaching.**

Although the NCSU program graduates were unsatisfied with the structure and length of their field experiences, all six teachers in this study felt they had valuable learning experiences during their student teaching placement. In general, all the teachers had positive feelings about their placements, specifically their host teachers. Alexander commented that he enjoyed his host teacher because he had good classroom management, had a very casual approach in the classroom, and treated students with respect. Matthew also viewed his host teacher as “very competent” and helped him to “do well as a student teacher - to become a teacher, to be prepared for my own class” (Introductory Interview). Heidi stated that her host teacher was “outstanding.” She expressed the value she found in his mentorship when she stated:

I'm with a teacher who's phenomenal too – I'm learning a lot, I'm doing a lot, and I think I'm going to be better off because of it, but if you get a host teacher who's like not very helpful or not a very good teacher for that matter, then I think it really would be very damaging to you like you get in kind of you get out what you put in and, um, if your host teacher won't let you put in. (Preservice Interview)

Most of the lessons learned from student teaching placements centered on what teachers took away from the observation of, and mentoring from, their host teacher. Though all teachers made positive remarks about their host teacher's influence, the description of this influence varied according to the teacher's level of practice. All six teachers claimed to have modeled in some way their own teaching practices after their host teachers'. Yet what they valued in their host teacher's practice that was later incorporated into their own practice was different for the teachers with low and mean levels of reform-based practice than it was for the two teachers with high levels of reform-based practices.

The teachers in this study with low to mean levels of reform-based instructional practices expressed a teacher-centric focus on what lessons they gained from their host teacher and as a result assimilated models of teaching focused on procedural aspects for planning and maintaining control of the classroom. Much of what was valued from the modeling and mentorship of the host teacher was gaining skills for classroom management, resources for curriculum development, and personality traits or characteristics found to be useful with a middle or high school student population. Heidi was representative of this group in that she wanted to have the same rapport with her students that her host teacher had. He had told her teaching is like “acting.” She described what this meant for her own actions:

...he was very much like that, so I think that that really got put into how I feel. And he said, he's like, you know, um, teaching is kind of like acting, like you gotta, like -- he's like, I'm not like this when I'm at home. He's like, but you gotta do it to, um, make it so they buy in. And I do that all the time. Like, I do creepy things and it's so that I help them buy in. (RoPPE Interview)

Heidi also described taking on other procedural aspects of her host teachers' practices such as his homework checking policy and focused on the resources she gained such as all her host teacher's guided note packets. She described how this impacted her own instructional practices:

And I -- they gave me like their whole guided notes packet and everything, and I've really taken that and modified it, ah, a lot. That was really helpful to be able to have something like that. I always do guided notes for all my units and I think it's a big help. And they really helped organize my thoughts as I was, um, translating that. In addition to that stuff, I mean, it was everything that we talked about before, his personality. (RoPPE Interview)

Alexander was the only teacher in this group who believed he couldn't replicate his host teacher's practices. Though he enjoyed his host teacher and found the lessons he taught him to be valuable, he couldn't reproduce his teaching style because "his kids were different" and his host teacher's strategies would not work with the population of students in his classroom.

Matthew and Stephen also discussed ways in which they modeled their teaching after their host teacher. However, though they gained some similar procedural or management lessons from their host teacher, the focus of their discourse regarding modeling themselves after their host teachers centered on assuming models of practice based on students' needs and learning.



Matthew was very enthusiastic about his host teacher and stated the placement “gave me the mold from which to cast the way I teach now” (RoPPE Interview). He described many things that he took away from this teacher such as his methods for dealing with students and how to layout the classroom. Matthew emulated his host teacher’s interactions with students, as well as his ideals such as holding high expectations for all students and being honest with students. Still, Matthew extended the way in which he modeled himself after his host teacher to include the need to provide authentic experiences for students. Mathew stated, “And, to provide authentic experiences in science so that the students can use what they know to build new information on what they need to learn” (RoPPE Interview). Along with trying to model “authentic experiences” he also took away an understanding of the need to vary his assessment strategies because of the diversity of learning styles/needs in the classroom. He included performance-based assessments and project assessments into his practice based on what his host teacher had done in his own teaching. Stephen also incorporated a focus on assessments into his practice from his host teacher. He learned about and used a lot of formative assessments to check for student understanding. He also took away the importance of making science relevant to students’ lives. His host teacher reinforced his perspective that teaching science was more than just focusing on facts and information. He stated:

I think after student teaching I started to get a different perspective. You know, we’re not here to teach the information, we’re here to teach the skills, they’ll learn the information some point later if it’s important, otherwise, they will forget the information but hopefully they will learn the skills that went along with it. (RoPPE Interview)

Stephen was also a bit unique in what he took away from his student teaching experience and host teachers. He found that he gained a deeper understanding of the depth of content needed to

teach and how to incorporate current events into the curriculum, by having the freedom to create and implement his own six-week unit on evolution and genetics. Though most of the other teachers did design and teach at least one unit, none described in detail having as much time to implement their unit. Stephen's description of his host teachers (across his three placements) was also distinct in that, though he did model some of their practices, he did not feel he needed to be like any one of them in particular. He had a lot of positive experiences to draw on, but he felt he could develop his own style too. He stated:

I thought they all were effective teachers and so just simply having them as models gave me at least 3 different looks of what really good teachers were like. They were all different in what they did and they were all effective so I figured out I can be myself and be a good teacher I didn't have to model myself after just one person. (RoPPE Interview)

Having the fortune of three placements with three positive host teachers with different styles afforded him the chance to consider the development of his own style rather than just imitating their practices.

**Take away lessons from teacher preparation varies according to level of practice - teaching as the acquisition of resources and skills vs. developing a research-based understanding of teaching.**

Overall, the take way lessons from preservice teacher preparation varied according to level of practice. As outlined above, teachers were generally satisfied with their methods courses, and peer and faculty relationships. Though the graduates from NCSU desired more practice and felt less prepared to teach science as a result of this, they valued their student teaching placements, as did the other three teachers. Throughout all the discourse regarding the

experiences in their education courses and field placements, what teachers most valued as a take away lesson from their preparation varied according to level of practice. The teachers categorized as having low to mean levels of reform-based instructional practices, discussed the value of their teacher preparation as a function of how much they acquired in terms of resources and skills. As Amanda described it, she liked the “concrete stuff” from her methods courses. She feels like she “got” a lot of skills from her teacher preparation such as technology skills, resources for teaching, and lesson plan templates. Though she spoke of being confronted with lots of ideas about teaching and the notion of trying to use inquiry has stuck with her, she does not describe how these experiences helped her develop an understanding of teaching centered on the theories of learning and teaching presented in her program. Alexander and Mark’s dialogue also focused on acquiring skills for teaching highlighting the resources and lesson planning skills they gained as a result of their preparation.

All three of the above teachers reported feeling underprepared to teach science and viewed their preparation program as deficient in the amount of field experience provided to preservice teachers. It is not surprising that with the conflict these teachers experienced regarding the theory and practice of reform-based pedagogy, these teachers’ descriptions of their process of learning to teach was focused solely on teaching as the acquisition of skills and resources; practice apart from theory. Though Heidi did not discuss having a conflict of theory versus reality and felt well prepared by her teacher preparation program valuing her preservice program experiences, her discussion of what she took away from these experiences was very like those of three teachers than those of Matthew and Stephen. She liked the repetition of watching demonstrations and discrepant events to be able to replicate these skills in her classroom, particularly because most of the examples were Chemistry based. She found this very useful,

because it gave her concrete activities she could replicate in her own classroom. Beyond acquiring these skills, she found the lesson planning format that was provided to be very beneficial and believed, “that was really good, like, to -- to carry that over for that sort of thing” into her practice (RoPPE Interview). The things she did not find value in related more to the theory behind the skills she found so appealing in her methods classes. Heidi expressed that the assigned readings for these courses did not “really influence me one way or the other...I honestly don’t even really remember most of, like, the stuff that I read” (RoPPE Interview). This lack of interest in the assigned readings behind the methods of teaching science also aligned with her opinion of the required research-based teaching rationale paper and defense as a part of her program. She expressed not benefiting from this assignment and stated, “overall, long-term, I haven’t even thought about that since I’ve turned it in” (RoPPE Interview).

The take away message for Matthew was different than it was for Heidi even though they were the graduates of the same teacher preparation program. Throughout his experiences in the program he also valued acquiring skills for teaching and associated resources. He described his preparation as aiding him in understanding the basics of organizing and planning the day to day of teaching, learning expectations for good unit planning, and learning how to work in cooperative groups. However, Matthew’s descriptions of what he gained from his preservice preparation went beyond just acquiring skills for teaching, but included a focus on developing a research-based understanding of teaching. In discussing the impact of his methods courses he stated, “being introduced through the learning cycle on how students learn. Those are all things I learned in the science education courses and that I bring into the classroom here” (RoPPE Interview). Matthew frequently discussed the value of learning the research behind good teaching and student learning. Through this teacher preparation he found he learned “how to

arrange learning experiences so that students get the most out of the experience” (RoPPE Interview). Similar to Matthew, Stephen’s discussion of what he learned in his preparation centered on a research-based understanding of teaching and learning. He described the constructivist framework learned in his program affected his beliefs and practices. Stephen also felt that beyond acquiring skills related to teaching, he developed an understanding of inquiry and students construction of knowledge. He attributed his understanding of how “learners construct their own understanding has kind of become my philosophy or belief ...I think that beliefs corresponds with the practice,” and he credited this understanding to his preservice coursework (RoPPE Interview). He also felt he developed a different perspective on the science content, a perspective more at the level of the learner, and how to include this focus on student learning in the development of his instruction. He described this when he stated:

...looking at the subject matter from a different perspective, more at the level of the learner, what previous experience do they have to draw on, how can I use analogies when I teach this, how can I relate it to the real world...with practicing some the sample lessons that we did in the Methods program, and actually taking the content and making up the unique lesson plans and presenting them and teaching them to our peers. Kind of helps you know what level you should teach it at, what your focus should be, what your learning outcome and objectives are and all those things so it gave you different perspective on the content. (RoPPE Interview)

**Teachers’ sense of preparation linked to perception of teacher preparation program’s ability to prepare teachers for the “real” classroom.**

The teachers’ sense of how well prepared they were to teach science was highly dependent on the combination of the above described teacher preparation program experiences

and field placement experiences. All six teachers stated they felt somewhat prepared to teach, however the discourse surrounding feeling prepared to teach was overwhelmingly centered on the impact that their field placements and teacher preparation program components had on their practice. It is not surprising then that the graduates from NCSU, Alexander, Mark, and Amanda felt differently about their sense of preparation than the SU and UI graduates. In this case, it was not enough for teachers to state that they enjoyed their teacher preparation, or felt somewhat prepared. Alexander, Mark, and Amanda found many areas in which they felt underprepared as new teachers. Mark described how he would rate his level of preparation to teach science. He stated:

On a scale of one to ten, probably around a six or a seven. I think that I lacked – at least in a lateral entry program – I lacked a lot of the experience necessary like a lot of the understanding of how the classroom worked. (Introductory Interview)

Alexander and Amanda agreed with Mark that there were several things lacking in their preparation about working in the classroom. Alexander felt he was unprepared for adequate classroom management, commenting “Um . . . Yeah. . . . So, the behavior, I was completely unprepared . . . to deal with” (Preservice Interview). Figuring out how to manage the students took precedence as he assumed the role of teacher in his own classroom, and often left him frustrated that he could not do more kinds of activities that he learned in his preservice preparation. Amanda also struggled with her classroom management, feeling unprepared to teach science to students with diverse needs. She remembered taking a class on “exceptional children” but found she “really struggles with those kids right now” and “had to sort of figure it out along the way” (RoPPE Interview). Like Mark and Alexander, Amanda felt she could have been better prepared to deal with classroom management. She stated, “And that, I don’t think I

practiced enough and would have been good. Because that's something I don't think is so student-specific. I think you could practice that" (RoPPE Interview).

While the NCSU graduates were given tools for implementing reform-based instructional practices, their comments reflected they were not given adequate preparation to implement these tools independently. Due to this they appeared to develop a context dependent understanding of these teaching practices, the context being in a methods course as opposed to a secondary classroom. Because the three NCSU teachers had a sense of being unprepared, they experienced a conflict between the theory and practice of reform-based instructional practices. Much of the discussion of reform-based pedagogy reflected this conflict because these teachers believed it might be good in theory, but in reality it was not valid. Amanda described feeling much of what she learned was based on "ideals" and left her unprepared to implement it in her current teaching position. She expressed, "preservice seems to be, like -- like the ideal -- this is your ideal kid, your classrooms and stuff, this is how it should work...but it lacks a little bit of reality" (RoPPE Interview). She emphasized how she struggled to put this into practice stating:

I think it gave me a lot of tools, a lot of background and, you know, this is how it can be kind of thing, but some of it was a lot of ideals. Like, this is ideally how kids learn. This is ideally how you're going to reach them. These are great ways to do it. But, in the reality of it, maybe I just haven't, I don't know, integrated it well yet or I could still try it and maybe it will work and I just don't know it. (RoPPE Interview)

Mark also emphasized he felt his methods courses "revolve around an idealized classroom" (RoPPE Interview). Similar to his previously mentioned comments about needing more practical experiences in the NCSU teacher preparation program, he felt that he wasn't fully prepared to

implement what he learned in his teacher preparation program, because it was not practical in the classroom.

I'm in my third year of teaching and this may just be me. I'm not saying that it's not – that every teacher is like this but it's taken me until this year to really be able to get my head around all the individual student issues and not to be able to try to implement some of the things I was taught successfully at State. And some of the stuff at State, or just in general when you teach your class, is not practical. But I mean sometimes it is. I mean it's really pick and choose and it's hit or miss in a lot of ways. (Preservice Interview)

Unlike the three graduates of NCSU, Matthew, Heidi, and Stephen all professed feeling a high degree of being prepared to teach science. This was reflected in statements such as Matthew's when he commented, "I thought my science education courses really prepared me well...And now as I reflect on that, I know that I had a great experience in the entire program, and I really benefitted from it" (RoPPE Interview). Matthew credits being very well prepared to the combination of "valuable" student teaching placements and support from peers and professors throughout this teacher preparation. He stated:

I thought that my student teaching placements were very valuable and, um, I felt highly prepared for my first teaching position. And I felt well supported by my – by my professors and colleagues in the program in order to be ready, um, for my first job. (RoPPE Interview)

Heidi, also a graduate of SU, echoed Mark's sense of preparation, frequently discussing how well prepared she was for her first teaching position. Heidi often compared herself to other



teachers from different teacher preparation programs feeling she was much better off than they were. She stated:

To be honest, I don't know what, because -- because it was pretty good. Like, when I talk to other people who are teachers, when I talk about the program that they went through, I feel like I was so much better prepared than they were. Like, I -- and I knew a lot more what I was supposed to do, like, in terms of, like, my requirements, like, what topic I needed to teach when, and like what I had to do by when. (RoPPE Interview)

When beginning her first full time teaching job, Heidi stated she “honestly didn’t feel like a first year teacher. Like, it was no big deal” (RoPPE Interview). Heidi attributed this feeling to her sense of preparedness from her preservice preparation and a long-term substitute position she held after graduating from her teacher preparation program. Stephen felt the same way about his preparation from UI. Stephen felt he was prepared “As well as could be expected because they can’t teach you everything” (RoPPE Interview). Though Stephen mentions that teacher preparation can’t prepare you for everything, he did not believe he was lacking anything to teach science effectively. Looking back Stephen was glad he completed his teacher preparation at UI as he had contemplated other options for his teacher preparation. He stated:

I was looking at 13 month programs because it seemed quick and easy and cheap so I could get it out of the way with less money. One of the big reasons that I went to Iowa was because I had a sister-in-law that went through the program and it was a great thing for her, it got her a good job and all that stuff. Also, the degree that you were able to learn was not the same as the 13 month program. (RoPPE Interview)

Like Matthew and Heidi, Stephen was explicit in the value he found in his program and this

contributed to his sense of preparedness to teach science.

### **Summary Teachers' Backgrounds**

Teachers' descriptions of their backgrounds, both personal and professional were used to understand how early socialization experiences as both student and teacher contribute to the variation seen in the practices of these six teachers. Lortie (1975) asserts that these early experiences exert the most socializing influence on teachers compared to their teacher preparation and occupational socialization. The data available for this analysis showed that teachers' shared similarities in their personal backgrounds, and shared similar socialization experiences during their time spent as science students. All six teachers' early visions of good teaching were shaped in part by their best and worst science teachers. While all teachers describe having a very positive "good" teacher to help shape this vision, this was rare as these teachers had many more examples of "bad" science teaching. There were common attributes that these teachers valued of the good science teacher. The "good" teacher had a good personality and provided experiences and pedagogy that was not the norm, as opposed to the bad teacher who did not personally relate to students and primarily lectured and focused on content memorization. All of these teachers tried to incorporate attributes of their "best" science teacher into their visions about science teaching, regardless if they were able to enact this vision. Four of the six teachers (those with low/mean levels of practice) became more like the common teacher they encountered as a student, enacting a teacher-centered pedagogy. Previous research shows that "teachers are socialized in the earliest part of their student careers" which "unconsciously shape prospective teachers' beliefs about teaching and learning" (Feiman-Nemser et al., 1999 p. 14). The data also showed that as a whole, these six teachers shared very similar science college coursework experiences. Due to the rarity of the "good" teaching

experiences, most of what teachers described from their college science courses was more akin to the descriptions of bad science teaching. These findings suggest the socialization of teachers may not be solely predetermined by personal histories as Lortie and others have suggested. Both negative and positive experiences with teaching as a high school student and undergraduate can promote a belief in, and enactment of, reform-based instruction.

However, the data on personal backgrounds showed low/mean practice teachers and high practice teachers differed with respect to their scientific research experiences. The low/mean practice teachers had little to no scientific research experiences beyond the scope of what was required for their coursework or college degree program. The high practice teachers had extensive research experiences that fell outside the normal requirements for their degrees. They had opportunities to develop skills and learn processes of science, being socialized into the scientific profession, which the low/mean teachers did not have. These significant socialization experiences related to research experiences support the notion that other life experiences outside of formal schooling and prior to teacher preparation can influence teacher socialization. Zeichner and Gore (1990) describe the rising influence of these outside experiences as more “nontraditional” students enter teacher education with other significant experiences influencing their socialization process.

While teachers’ personal backgrounds were fairly similar, their experiences from their professional backgrounds were more divergent. The one area in which all teachers were aligned was with respect to certain aspects of their teacher preparation programs that they found valuable to their preparation for teaching. For all six teachers, content specific methods courses were found to be the most useful classes among the required coursework. Within these methods courses they had similar experiences, such as modeling of reform-based teaching, micro-teaching

experiences, focus on unit and lesson planning using state learning standards, cooperative learning strategies, and positive relationships with methods faculty.

Though all six teachers had similar positive methods course experiences, the overall discourse regarding the quality of their program varied among the graduates of the three universities. Zeichner and Gore (1990) summarize Feiman-Nemser's 1983 critique that when ascertaining the role teacher preparation programs play in the socialization of teachers, "we need to distinguish between campus-based and field-based elements because they represent different and often competing notions of the process of learning to teach (p. 16). In this study's findings, the teachers regarded the process of learning to teach in the field-based elements as most important. The main difference among these graduates' perceptions of their overall teacher preparation quality was linked to the structure and duration of their field practicum experiences, which varied greatly among the three universities. Teachers from SU and UI who experienced more time in the field, 200 to 400 hours more than NCSU graduates, also expressed greater satisfaction with the quality of their preparation in light of their field experiences. The three graduates from NCSU expressed dissatisfaction with the extent of their field practicum experiences. These three teachers felt they needed more practical experiences to be prepared for the realities of the classroom, and discussed struggling with practical matters in the classroom leaving them unable to focus on implementing what was learned in their preservice preparation.

Regardless of the extent of their field experiences, all six teachers found the time they had in their placements to be valuable to their professional development as teachers. Most teachers were overwhelmingly positive about their host teachers and the role they played in their development. The description of how host teachers influenced the teachers differed between the low/mean practice teachers and the high practice teachers. These findings are in line with

previous research documenting the differential effects that field based socialization experiences have on preservice teachers (Zeichner & Gore, 1990). While all teachers in this study expressed modeling their own teaching after their host teachers' practices, the low/mean practice teachers took away lessons and modeled behaviors focused on procedural aspects for planning and maintaining control of the classroom. The high practice teachers also took away these lessons, but also discussed learning about and modeling teaching practices that were based on students' needs and learning. One teacher, the highest practice teacher, described being able to incorporate lessons learned from his host teacher while figuring out his own teaching style.

Another way in which the low/mean practice teachers differed from the high practice teachers with regards to their teacher preparation is in what they valued most from their teacher preparation. Low/mean practice teachers expressed finding value in acquiring resources and skills for teaching from their preparation, but did not find the theories of teaching as useful. The high practice teachers' discussion also appreciated acquiring these same skills, but valued the research-based understanding behind the practices. They related their beliefs and practices to the theories on teaching and learning presented during their preparation.

Finally, the teachers' sense of preparation, dependent on their teacher preparation program experiences and field placements, differed among the graduates from the three programs. The NCSU graduates expressed a greater sense of being underprepared for teaching feeling as though they lacked classroom management skills. These three teachers also experienced a greater divide between the theory and practice of reform-based teaching, feeling underprepared for implementing these "ideal practices" in the "real classroom". The graduates from SU and UI did not express these same sentiments and were explicit in how their program contributed to their feelings of preparedness to teach science.

## **The Local Context**

### **Greater Feelings of Professional Autonomy Experienced Among Teachers with High Levels of Reform-based Teaching Practices**

The amount of professional autonomy experienced by these six teachers varied among the different levels of implementation of reform-based practices. It was more common among the teachers with low to mean levels of practice to express feeling little professional autonomy across various aspects of their role as science teacher. One facet of the professional teaching role in which some expressed little autonomy was in making curricular and instructional decisions. Alexander described his frustration with the level of control he thought he had over instructional decisions after attending his first staff meeting stating, “You’ve got to have this common assessment group! And, you guys are gonna teach the same lesson on the same days to the same people! And, we’re all going, Oh my God! You’ve got to be kidding me” (Beliefs Interview, 2008). These teachers discussed being told what to teach, in what order, which labs to use, and which assessments to give. Heidi expressed feeling little autonomy in all of these areas. In her school, Heidi felt she lacked control over the order of the content in the chemistry curriculum, even though it went against what she thought was logical and best to help students develop understanding. She stated:

It’s, like, an expectation of the school. Um, so, like, stuff like that, I kinda do – I also, like, the order of chemistry, like, doesn’t it seem a little weird that it’s November and I’m just starting to talk about protons? I think it is. Like, but, like, we go in the most bizarre order. But I’m not allowed to go in the order I want to. Like, I’m supposed to go in the order the school wants... So, like, I had to do gasses and stuff like that before we’ve even

talked about, like, what a proton is. I just think that's not right, but, like, I can't control that. (Beliefs Interview, 2008)

Beyond feeling like she had no choice over when to introduce certain chemistry concepts, Heidi also felt she was not given professional judgment over which laboratories to use. Heidi described her feelings regarding these labs stating:

Um, well, it influences my actions, I'll say, because, um, I have little control over the labs that I do, and some of the labs are horrible Like, they're, like – they – they don't even – like me and the other chemistry teacher that got hired at the same time, we look at some of these labs and we're, like, what are they supposed to get out of this. Like, we don't understand, like, it's so stupid, but, um, we have to do it. (Beliefs Interview, 2008)

Heidi reiterated often that she did not agree with the laboratory activities that she was “forced into.” She found them “ridiculous” and felt the students didn't get anything out of them.

Regardless of her professional assessment of the laboratories, she had little autonomy to choose her own course of action with regards to modifying or implementing new laboratory activities with her students. Along with feeling forced to use these laboratories, Heidi also stated she was given little choice in several of the assessments she gave to students. Regarding assessments Heidi stated, “Um, some of our assessments, like, we have no control over, like, the mid-term and stuff like that. Like, it's pre-made. When I got here they were, like, this is our mid-term, this is what we give” (Beliefs Interview, 2008). As with the other teachers who experienced a lack of professional autonomy, Heidi often expressed feeling frustrated and discouraged by the lack of decision-making she had over curriculum, laboratory activities, and assessments.

Compared to these teachers, the high level of reform-based practice teachers described a much different atmosphere of professional autonomy at their schools. Stephen perceived having a great deal of control over what he taught. When asked about the amount of curriculum flexibility he perceived having, Stephen expressed having, “as much as I want really” (RoPPE Interview). He described having a lot of autonomy to focus on depth over breadth when it comes to the amount of content he plans for in his curriculum. He stated:

...we get through about ½ of what a typical chemistry class would get at and we focus on the process skills. So, there is no one in the district telling us what to do, we’re still running a chemistry class even though we don’t get into all these other topics. (RoPPE Interview)

Much different than Heidi’s experience with professional autonomy, Stephen frequently expressed having a high degree of decision-making ability. He proposed a new Biotechnology course that was accepted by the administration. In this course, Stephen felt he had complete autonomy to, “teach whatever I want as long as it fits a general learning objective and as long as it hits on what the districts wants to focus on” (RoPPE Interview). Along with feeling autonomous in what he could teach, he also expressed a sense of independence in his teaching role stating “No one is looking over my shoulder so that is kind of nice” (RoPPE Interview).

### **Influence of administrators on teachers’ autonomy**

Another facet contributing to the teachers’ sense of professional autonomy was their interaction with administration. In many cases, either the district administration or the school building level administration was perceived as inhibiting the level of professional autonomy teachers experienced. Alexander expressed having a contentious relationship with administration



in his school describing them as controlling and unsupportive of teacher ideas. He described the administration as “coming down hard, top-down, strong-arm tactics...on the teachers” (Beliefs Interview, 2008). Alexander repeatedly described the administration as wanting to control everything and how it “drives him nuts.” He described an environment in which he felt that rather than being viewed as a professional, the administrators wanted teachers to just comply with them. He stated:

If we can keep them out in the hall...we can actually teach people...which would be kind of cool. But it is. It’s a divide-and-conquer... ..world. They want all the teachers...no dissent...no anything...march in line...um world. They want all the teachers...no dissent...no anything...march in line. (Beliefs Interview, 2008)

Other teachers described the administrators forcing certain routines or schedules on them that hindered them from doing what they desired. Amanda described lacking control over how to structure the beginning of her class periods due to her school’s administration requiring teachers to use the first ten minutes of class for dealing with attendance issues. Amanda described trying to come up with independent written activities to start class so she could comply with the administration’s request, but she stated, “It’s not what I would ideally do” (Beliefs Interview, 2008). Heidi also expressed feeling “hindered” by the schedule of her class periods. She found the administration’s design for 40-minute class periods to be inadequate, particularly when trying to implement laboratories. She stated:

And, like, I -- I feel myself saying, like, oh, well, we’re doing lab today, oh, but all we’re doing is doing it. You won’t be able to answer anything about it for another week, but we have to do it today because it’s our lab day. It’s like, I hate -- I hate doing stuff like that, but what am I supposed to do? (RoPPE Interview)

While most of the low to mean practice teachers expressed feeling hindered by the administration, Mark was an exception. He felt that although the administration enforced school wide efforts such as teachers' participation in professional learning communities; they were "relatively hands-off" and "let me teach in the classroom that way I feel I need to teach" (Beliefs Interview, 2008). Matthew and Stephen also shared the feeling of professional autonomy to teach the way they saw fit. Matthew expressed a high degree of professional autonomy, feeling he knew what was best for his students and had the respect of the administrators to implement this. He stated:

I know what – I think I know what's good for my students. And so, um, really, honestly, I see them – and I – I mean, they're – they support me and they support, um, what I do. I think that's the role of the administrators, to be a support person for the teacher. But I really don't see them as, um, having a big influence on how I conduct my classroom.

Does that make sense? (Beliefs interview, 2008)

Stephen shared this sense of autonomy due to his administrators' support of his teaching methods. He felt their support gave him the "freedom" to engage students in controversial topics in the classroom without having the "thought you were going to get fired" (Beliefs Interview, 2008). These teachers greatly valued this level of autonomy and felt it allowed them to function independently in their teaching roles.

### **Influence of colleagues on teachers' autonomy**

Just as administrators contributed to the teachers' sense of professional autonomy, so did their interaction with their colleagues. Some teachers felt the colleagues set a tone for the culture of expectations for teaching at the school. Teachers such as Heidi, who was only in her second year of teaching, felt she lacked the independence to teach in ways that were different from her

more experienced colleagues. She described feeling forced to do what the other chemistry teachers were doing stating, “Um, and there’s a -- there’s a certain regime that’s in the chemistry department that I am required to fit into” (Beliefs Interview, 2008). She found that her chemistry colleagues “didn’t care what you think” and as a result this environment shaped her teaching actions. Feeling a low level of autonomy amongst her teaching peers resulted in Heidi feeling conflicted about her teaching actions not mirroring her beliefs about teaching. She stated:

Um, well I’ve had a lot of influences on my practices. I don’t know if my beliefs have been changed. There is a disconnect, I think, between the two. Um, because I think a lot of it is shaped by the environment that I’m in. (RoPPE Interview)

Mark also felt that he had to fit in with the practices of the other chemistry teachers in his department, though he did not view this lack of independence as negative. He described his collegial interactions positive in that they worked together to help the same students. The teachers in his department worked together, “to make sure we’re all on the same sheet of music about how we teach certain things” including using the same labs and tests (Beliefs Interview, 2008).

Teachers like Heidi and Mark described their relationships with their colleagues as limiting to the autonomy they had for making instructional decisions. This stands in stark contrast to how Matthew and Stephen perceived the influence of colleagues on their teaching. Matthew exemplifies this when he stated that in his school “I don’t feel pressure to do things like other teachers. So, hopefully that’s how they feel about me” (Beliefs Interview, 2008). He felt independent from other teachers and no pressure to mimic other teachers’ practices. He did feel like he was a team player by working with other teachers so that students get “similar

experiences” across the school. However he described that this did not strongly impact what he did in his own classroom. He commented:

You know, I share my – my, ah, my ideas with them, and they share theirs with mine.

And if there’s something that I think is useful that they do, then I will use it. And if I think there is something that wouldn’t work for me based on my philosophies, then I’d – I’d discard it. (RoPPE Interview)

Having the autonomy to decide what was useful to him while collaborating with peers provided Matthew an environment where he felt he had the authority to do “what works for me” (Beliefs Interview, 2008).

### **Most Teachers Perceived the Structure and Content of Their District Provided Professional Development to be Inadequate**

Throughout the qualitative analysis, teachers’ views on their professional development were not prevalent in the data. However, due to the significance this variable had in the quantitative model, it is worth noting any expressed similarities and differences among the teachers with regards to their professional development opportunities. The majority opinion of these teachers was that the professional development offered by the school district was not worth their time. Some teachers such as Amanda found the professional development activities were not effective for her because she had already learned the material in her preservice program. She stated, “I was like, I had already done this! For the last four years I have been learning this stuff, you know. Like, I’ve got it, thank you” (RoPPE Interview). Mark who commented, “I don’t find the professional development experiences helpful at all” echoed Amanda’s frustration with the content of the professional development opportunities in his district. He explained:

I don't think the people who do the professional development, take into account that, all the teachers there have a degree in teaching. They all probably have had this diversity class through college. And, let's move it to the next level. Let's really do professional development, not this crap that. I'm sorry! (RoPPE Interview)

Like Mark and Amanda, Heidi too viewed the content of her professional development as well as the structure of these opportunities as ineffective. She found the professional development was "kind of boring" and too general in nature because "they make it ridiculous, because they have kindergarten teachers in with high school teachers" (RoPPE Interview). Due to this she viewed the instructional strategies presented as irrelevant stating, "Like, that's not going to work. Like, they -- they talk about these things. Like, some of it's fine. None of it's, like, earth shattering. But it's not geared toward what I'm doing" (RoPPE Interview).

Matthew's perspective on his professional development opportunities was slightly different. In his fourth year of teaching he found his professional development, "Um, it seems that over time they've become more useless" (RoPPE Interview). Matthew did acknowledge that when he was a new teacher he believed the professional development was useful as he "needed to soak up new ideas" learning about assessment strategies, learning styles, and technology in the classroom. While Matthew found the professional development was not as helpful to him anymore, he was unsure if this can be attributed to, "becoming more experienced or if it's because the things that we're focusing on in our district right now, um, are more clouded" (RoPPE Interview). Though Matthew had constructive things to say regarding his past professional development, Stephen, the teacher with the highest level of reform-based instructional practices, was the only teacher to express an overwhelmingly positive view of his district's professional development. Stephen felt that the district professional development

coordinators “treat us like professionals” going “out of their way to give you choices of workshops to go to” (RoPPE Interview). He commented that his professional development was not like the generic professional development he heard teachers from other districts describe where the emphasis was to, “make sure we tell everybody about the same topic it doesn’t matter if it is relevant to them or not” (RoPPE Interview). He believed his district’s workshops were relevant to his needs, engaging but not too long, and he attended them with his peer teachers.

### **Culture of Support**

As previously discussed, the cross case analysis of teachers’ views about their relationships and interactions with colleagues and administrators revealed the influence these individuals have on teachers perceived level of autonomy. However, another key influence colleagues and administrators had on teachers was the culture of support they provided. As is the case with other themes, the way in which teachers received support from these individuals differed across the range of reform-based instructional practices.

**While most colleagues are perceived as supportive, the nature of this support is important for teacher practice.**

A majority of the teachers’ dialogue about teaching colleagues included mention of the supportive nature of their peer teachers. Amanda represented this type of dialogue stating, “They’ve been great! Like, the people I work with have been amazing! I think that’s probably what keeps me coming back. Um, yeah. They’ve been pretty supportive, particularly the mentors that come in” (Beliefs Interview, 2008). Though these six teachers in general felt they were a part of a supportive peer culture, the kind of support discussed varied. Feeling supported for procedural or practical aspects of teaching extended across all levels of practice. For

example, Mark felt his colleagues support him by sharing the workload for different teaching tasks. He stated:

So, we share the work load as far as labs. So, for example...his primary job is to set up the labs. My primary job is to catalogue and develop the contents of the course...or, not the content, but the homework and that kind of stuff. And, maintain the website for the course. (Beliefs Interview, 2008)

Amanda also discussed procedural or managerial support, such as having help copying worksheets when she was running behind, or advice on classroom management to try to work out some student behavioral issues. On the other end of the practice spectrum, Stephen also felt his colleagues provided this kind of procedural support through the sharing of resources. He discussed the freedom to borrow whatever he needs from his fellow teachers.

With the exception of Matthew and Stephen, few teachers discuss a culture of support amongst colleagues that extends beyond the practical aspects of teaching, but provides support for instructional decision-making. Heidi did describe some discussion of a collaborative effort for how to best identify and deal with students' low math skills with colleagues in the math department. However, this type of collaboration concerning student learning was not prevalent in her science department. Mark also felt his relationships with his chemistry colleagues were "relatively open" and they support each other in their knowledge of content. He stated, "I feel that I could go to the other chemistry teacher and say, "Hey...I don't feel comfortable doing...limiting reagents,' for example. 'Can you maybe just go over it with me?' And so. We support each other through content" (Beliefs Interview, 2008). However these supportive relationships were not the norm for these teachers, nor were they focused solely on pedagogy.

Matthew discussed working with colleagues that were willing to provide as well as receive support from him regarding instructional decision-making. He stated, “If I want to do some activities that are very creative, other teachers are willing to do those, too” (Beliefs Interview, 2008). He valued the collaboration he felt within his science department using this collaboration to design new lessons and activities for students. He described this when he stated:

I've learned to work closely with my colleagues -- my other Earth science teachers, and I think that the benefit of working in a school with more than just one teacher in my subject. But I've been able to learn how to work with different teachers and come up with new lesson plans and activities. (Introductory Interview)

Stephen also valued collaboration with his colleagues stating, “So there is a much more collaborative school wide culture where everybody respects what everyone else does and they try to get involved and help out whenever possible” (Beliefs Interview 2008). He felt this culture of collaboration existed within the culture of his department as well as across the school, stating, “there is open dialogue” across disciplines like Mathematics and Social Studies. Stephen’s teaching office was located in a room with several other teachers from a wide variety of disciplines. The cross-disciplinary office space fostered the kind of collaboration that best supports student learning. Stephen stated:

So, we talk to the English teacher about this kid’s terrible about writing how can we help him or we talk to the Math teacher and they are teaching this right now and we don’t teach this till later how should we approach it so we are not inconsistent with the way you teach it. So it forces that collaboration which is really helpful for the kids too. That way they are not seeing thing different in every class and thinking the subjects are all isolated. (RoPPE Interview)



Stephen claimed this kind of collaboration also provided him with new ideas for his classroom instruction that he had not considered before, such as how to incorporate debate in his research class which he said he, “would of never thought of on my own” (RoPPE Interview). Along with this kind of collaboration came a sharing of teachers’ instructional practices. He valued the impact that all these instructional perspectives had on his own developing pedagogy. Stephen stated, “if the people around you are doing really cool initiative neat things you’re more likely to hop on board and try new things and not let yourself get too comfortable but always push yourself and be willing to adapt” (RoPPE Interview). Not only was Stephen exposed to “cool initiative neat things”, but he also felt he was exposed to interesting teaching models. He stated:

I’ve benefited from being around good colleagues who have developed models themselves. In here there is one set that has been brought in from, Texas and California that were established there and worked amazing. Last year it was ones that were self-developed at Iowa that worked really well. So, having the exposure to a lot of different ways has allowed me to try different ways and have tried to find the ones that work well for me. (RoPPE interview)

Stephen’s description of this culture of support and collaboration, which exposed him to many different kinds of instructional practices, fostered his view of teaching and allowed him to grow in his instructional practices. This type of support for teaching is much different than the more commonly described support for procedural or administrative aspects of teaching.

**The degree of fit perceived by teachers was associated with philosophical alignment with and support from the administration.**

The nature of support teachers’ felt from district and school level administration mirrored the opinions teachers had regarding their administrations’ influence on their level of professional

autonomy. Greater teacher autonomy was associated with a greater sense of support from district and school administration. Low to mean level of practice teachers such as Alexander expressed feeling a lack of support from administrators. When he was initially hired he felt he was “cut loose” by his administrators and did not get a true mentoring experience. He explained the position of his administrators as, “they were like here’s the class, they have textbooks, here’s the computer, have fun” (Preservice Interview). Just as Alexander had desired more administrative support, Mark found that he had desired an administrator that could have developed a positive and supportive school culture. Mark described his school principal as being close to retirement and lacking “the administrative push to really develop a school culture” because she was only “concerned with the nuts and bolts that made the school run” (RoPPE Interview). Mark believed this lack of administrative driven school culture during his first few years of teaching shaped his early experiences as a new teacher. When the principal retired during the last year of the study, he found there was some improvement with the new principal and was hopeful for the new administrator to help the school develop a supportive culture.

Matthew and Stephen, who both felt a high degree of professional autonomy due in part to their interactions with the district or school administration, also felt a high degree of support from administrators. Matthew described this stating, “And so, um, really, honestly, I see them – and I – I mean, they’re – they support me and they support, um, what I do. I think that’s the role of the administrators, to be a support person for the teacher” (Beliefs Interview, 2008). He noted that although he felt supported, he didn’t think it influenced how he conducted his classroom, which may be due to the high level of autonomy he felt to teach how he saw fit. Matthew also felt support from the administration for classroom resources. He stated, “They give me a good budget and I am very, um, supported – very well supported to buy – purchase the learning

materials that I would like to have for my students” (Beliefs Interview, 2008). Stephen also expressed having a high level of support from his administrators. He described the attitude of his administrators stating, “They always come back to this is about you, you are the people on the ground we make the money but you’re the people doing it and we are going to do the best to support you” (Beliefs Interview, 2008). He described the administration’s “support behind whatever you see as important” as really helpful to him as a teacher, especially when dealing with parents. Stephen’s administrators have told him they “have his back” when dealing with parents stating, “I think when the school is supportive of the teachers rather than the parents or the students it automatically give you more confidence and freedom in what you want to do”(Beliefs Interview, 2008). He also valued the fact that his administrators were appreciative of the good work teachers do and he has heard “thank you from administrators like a 1,000 times this year”. Stephen emphasized the nature of how the administration’s opinions of, and interaction with, teachers impacted his feeling of being treated like a professional and supported to be the best teacher possible. He found administrators “really do treat their teachers with respect and I think they get a return to them because they get more respect. When they engage in conversation rather than dictate” (RoPPE Interview). Stephen described the administrators as being sensitive to teachers’ professional time and scheduling meetings around teachers’ other professional duties to have as little impact on their planning and instructional time. He described this stating:

I think that goes back to how the administrative attitude toward you affects your philosophy on it. You can just tell where the priorities lie, priorities lie not in use doing our bureaucratic red tape, but it’s getting you out so that you can prepare for tomorrow as soon as possible and they stand by it. (Beliefs Interview 2008)

In addition to the differing levels of support cultivated by district administrators, there were also mixed opinions among these teachers regarding how well aligned they were with their administrators philosophy of education and their approach to reforms. For many teachers this manifested itself in a sense of degree of fit between their ideals and those represented by the district. Matthew described this feeling stating, “I would have to say that – if I can answer that question – that my beliefs and the school’s beliefs are pretty much the same, I think. So, I think that’s good, because that makes me feel like I fit well here” (Beliefs Interview, 2008). Stephen reiterated this point in his comments regarding his district. He described the overarching philosophy of his district as focusing on “the three R’s, rigor, relevance, relationships” (RoPPE Interview). He believed these values fit well within his own ideals of excellence in teaching as well as how the district communicated what this philosophy meant for classroom instruction. Stephen explained how his own vision of rigor in education matched that of the district vision of high expectations for all students and helping students meet these expectations. In describing what this kind of rigor looked like in his district Stephen stated:

So, not rigor in the view of, we get through 53 chapters, not that kind of rigorous but in the sense that we really push our kids to learn and critical thinking. Critical thinking is one of the biggest stands our district takes they are huge on that every teacher is teaching critical thinking and implements critical thinking strategies in their classroom. (RoPPE Interview)

The rest of the teachers did not share this degree of fit between the teacher and the overarching philosophy of district administrations. Alexander’s initial comments regarding his district were, “The district is just horrible, I think. Just...in all aspects” (Beliefs Interview, 2008). Alexander described a district focus on student success as measured by test scores and disregard for

teachers' own beliefs about good teaching. Mark also found himself in a district in which he did not agree with the overarching message coming from district administrators regarding the purpose of science education. He stated:

I think the district's policy is terrible! I think that the district only looks at success in science as based on test scores...and doesn't look at...how well we're preparing students to work in the sciences...be in the sciences...and even, just function in a scientifically literate community. I think there's absolutely zero focus on that. (Beliefs Interview, 2008)

The lack of focus on how to best prepare students to be scientifically literate and to work in the field of science was frustrating to teachers like Mark, who valued the ideals about science education learned in his teacher preparation program. As previously discussed, Mark came to see many of these beliefs as for the "ideal" world, viewing them not practical in part because of his district's focus. Heidi also described her district as not oriented to reform based principles and even resistant to them in some cases. She commented, "Reform, like change in it? Um, I feel like there has been no desire to change. Like, they're, like, reform, like, what do you mean? Like, it's – like, they - it's not something that discussed" (Beliefs Interview 2008).

The more these teachers perceived a lack of fit between their own beliefs about good teaching and the ideals learned about reform-based practices from their teacher preparation with those of the their school district, the more likely these teachers were to comment on feeling frustrated with administration, feeling unsupported in some aspects of their teaching, and generally feeling less autonomous in their role as a teacher.

## **Many Low to Mean Practice Teachers Suggest Students' Abilities and Backgrounds Thwart Their Ability to Implement Reform-Based Practices**

Throughout the qualitative data analysis, these six teachers frequently discussed their students and how they perceived students influenced their instruction. In the cross case comparisons patterns emerged regarding teachers' view of which students reform-based instructional practices were best suited for. The low and mean level practice teachers, typically engaged in a deficit-oriented discourse about their students, describing how they struggled to develop and implement reform-based teaching practices due to their students "lacking" something. As detailed below, the overarching message in these four teachers' discussions about students was reform-based teaching is more appropriate for honors students or students of high academic ability, students who are well behaved, and for students from non-minority and higher socioeconomic backgrounds.

Students' learning abilities were frequently discussed as a hardship to teaching in a manner that is more reform-based. Much of Alexander's discussion of his teaching was in relation to the level of students' abilities in his classes. He described teaching several different sections of biology, honors, regular, and "learning disabled biology" (Beliefs Interview, 2008). Alexander stressed spending a great deal of time worrying about how students of lower academic abilities understood a concept because he saw it was his mission to improve all his students' lives. Yet, he discussed being unsure how to best teach "these" students in the manner in which he was prepared to teach. He stated:

And -- and -- and how do you push that with, um -- then with different populations. So you end up with, like, we were talking about that one kid that was Autistic. How do I --

what's my research-based things for teaching Mendelian genetics to an autistic kid. I don't got a clue; I've got to make this stuff up. I'm fine doing that. (RoPPE Interview)

In his struggle to figure out how to apply research-based best practices for science teaching, he felt he resorted to other instructional methods for his students in his lower tracked classes. In his opinion he had to do this because "Actually, I'd lose them if I did what I did with the other kids! They'd be reading, misbehaving, or whatnot...And, they need a whole different kind of instruction" (Beliefs Interview 2008). Alexander claimed that his students could not easily engage in collaborative group work to get anything out of it. Instead he felt they needed a much more direct approach in which they could work on concrete independent tasks. His perception of his students' ability to engage in instruction that was reform-based had him focusing his instruction around lower level arts and crafts tasks for these students. He had students make paper mache cells when learning about cell biology, or paper mache turtles when learning about Darwin's work in the Galapagos Islands. In one example he stated:

So, now we've cut back . . . where . . . I'm making them . . . actually color sheets. Which is much more of a way of reaching the kids that needed the more concrete . . . identifying things and then just sitting there. (Preservice Interview)

Amanda also shared Alexander's sentiments regarding who reform-based instructional practices work best with. She described that "ideally, I would probably do some inquiry thing. I would really like to do more inquiry, where they're figuring out something, hands-on working through a problem" (Beliefs Interview, 2008). However, Amanda perceived the level of her students to be holding her back from using these kinds of instructional practices. She stated:

And that can be kind of hard, especially with my standard kids, which is, at this moment, the only experience I've had so far. But, um, they're very resistant to open-ended things. They want a clear set of directions. They want to know what's coming next. They want to know even, like, if they need to fill in an answer, where to find the answer. They don't stretch too far into, okay; I need to think in my head. I need to relate this. They have a hard time doing that because I think they've been sort of used to that, you know. This is how they've grown up with, this is what they're used to, and when you throw things out at them new they really buck at it. (RoPPE Interview)

Amanda valued inquiry practices and wanted to use more of them in her classroom. However, she found that “in Honors classes it works great, and the AP labs. But for standard, especially, with this demographic” it does not work (RoPPE Interview).

Beyond students' learning abilities, several of these teachers also viewed students' demographics or backgrounds as significant to the type of instructional practices they employed. Although Amanda was explicit in her views regarding this, as is evident in her above comment regarding her students, “especially with this demographic,” other teachers also revealed the same belief about students' abilities according to their backgrounds in more implicit ways. Three of the four low to mean practice teachers were employed in school districts with different racial and socioeconomic demographics than their own schooling, and had relatively little to no experience working with students from other backgrounds other than their own. These teachers frequently compared their current students to other populations of students they have observed, worked with, or been a part of in the past. The more teachers viewed students as “other” or different than themselves, or populations they have worked with in the past, the more they viewed these



students needing different instructional approaches besides reform-based teaching practices. For the teachers whose students did not share their racial or socioeconomic backgrounds, they often claimed that that reform-based instructional practices will not work with “this kind of student” or for “my kids” inferring that they work best for students who are from non-minority and higher socioeconomic backgrounds.

Much of the teacher talk about students, especially when comparing them to other student populations, described students in deficit-oriented language. Heidi described her previous students during her student teaching as “absolutely wonderful kids” and “they were just like, they were so nice and so good” compared to her current students which she described as “the kids are not as nice here and like drugs are an astronomical problem” (Beliefs Interview, 2008). This perception of her students being not as nice and having drug problems influenced her actions as a teacher to be “a little more defensive” and to start the school year off “a lot meaner”. Amanda also compared the students in her district which she described as a “lower urban setting” to students in more suburban settings that she was more accustomed to teaching in. The students in her district were much different than she had anticipated and she felt underprepared to deal with the fact that she found “these kids have real life problems” (RoPPE Interview). She strongly desired more preparation to teach in an urban district stating,

You know, it’s just a different set of kids, different set of background and stuff. And I think that might be something to look into, like, talking about teacher experiences with kids in a lower urban setting. Or, what are the kids like in a more farm setting. You know, that kind of thing. Like, what should you expect if you go into that kind of school. I was going in it expecting White County level kids and the kids don’t have it. They don’t have the reading level ability, they don’t have the home -- like, they don’t have

markers and stuff at home. And I'm assuming that they do when I first walk in and they don't. So I had to quickly adjust my mindset to what they had here. (RoPPE Interview)

Amanda described her school as low performing overall and within the biology department only 57% of students scored proficient. She had wished her preservice teacher education would have prepared her for what she viewed as the “reality of what it is here,” meaning the expectations for students at a “more free reduced lunch kind of school” (RoPPE Interview). Though Amanda felt underprepared to teach at this “kind of school” she greatly desired to relate to the students and have them know she was invested in them. She decided to move into the community to learn more about her students’ lives and understand what they dealt with outside of the classroom. She also became active in extracurricular activities, coaching the color guard, to further develop connections with her students.

This deficit oriented view of students influenced teachers beliefs that reform-based instructional practices were not realistic for their students because they are either: (a) resistant to it, (b) lack initiative, or (c) their classroom behavior prevented the teacher from implementing these types of practices. Amanda described how she perceived her students reacted to her attempts at incorporating inquiry style teaching practices. She stated:

But, um, they're very resistant to open-ended things. They want a clear set of directions. They want to know what's coming next. They want to know even, like, if they need to fill in an answer, where to find the answer. They don't stretch too far into, okay; I need to think in my head. I need to relate this. They have a hard time doing that because I think they've been sort of used to that, you know. This is how they've grown up with, this is what they're used to, and when you throw things out at them new they really buck at it. (RoPPE Interview)

Amanda continued to discuss how she viewed resistance to these teaching methods as unique to her students. She stated, “And especially this kind of student. They’re very unreceptive to change” (RoPPE Interview). Amanda explained she moved toward a direct instructional method because of student resistance, and that students “want to do as minimal as possible.” She found this level of student initiative was unfamiliar to her compared to her other teaching experiences. Though she felt high school students in general don’t want to do their schoolwork, her students were particularly low in “work attitude.” She stated, “Most kids don’t want to work. But, these kids, you really have to pretty much jump on your head to get them to do anything” (Beliefs Interview, 2008). Amanda viewed this work attitude as contributing to her inability to get students through a quick laboratory activity in the allotted amount of time. This influenced her thoughts regarding the design of the laboratory activities she chose for her classes stating, “And so, to do an inquiry lab that takes that long, they’re not really getting the material” (Beliefs Interview, 2008). She explained further stating, “I know right now if I tried an inquiry activity, it would probably fall, probably fail. And, they’d just sit there, ‘I don’t know what to do,’ and not even try, probably not even read the paper put before them” (Beliefs Interview, 2008). She moved toward using “concrete, manipulative type of stuff that I try to do with them so that they can feel it, they can see it, they can move it” (RoPPE Interview), but students were still resistant to this.

Mark also viewed his students as unable to participate in reform-based instruction due to motivational and disciplinary issues. He believed inquiry learning would not work well for “my kids” because they would not go along with, and could never see, the whole picture to make the necessary connections. These views regarding his students prompted him to engage in more direct instruction. He commented on this stating:

Well particularly with discipline issues, and student motivational issues, it just – there needs to be a very direct approach with them. They need to understand what your expectation is. Where you want them to do and be and on from there. And I think my first couple of semesters I was not very direct. I was very rounded out. I tried to let the students do it on their own and I figured out that students will not come to this conclusion on their own. They need a lot of structure. And they need to be – not forced – that’s not the right word but they need to have, they need to believe it’s their choice but not really have a choice. You know what I mean? (Preservice Interview)

Like Mark, Alexander’s perceptions of his students also related to his discussion about how student behavior and classroom management were linked to the type of instructional practices used in his classroom. Alexander described struggling with how to manage his class believing his students’ behavior prevented him from teaching in the manner he wanted, and prevented their success. He stated:

...well, for two-and-a-half years -- I’ve been struggling how do I take a bunch of kids that are punky, loud, um...different, obnoxious, out and out rude at times, don’t listen to you, um, kids and move them forward and try to hook them on success and learning and welcome them to the world of the educated. (RoPPE Interview)

Alexander desired to see his students succeed, but saw students lack of success as their responsibility because of their behavior. When a majority of his students failed their first test, he described having a conversation with the class telling them that their behavior was to blame. He commented, “Their behavior was completely inappropriate. They bombed it. They realized they bombed it. And, they wanted to redo the unit” (Beliefs Interview, 2008).

In all of these teachers' discussions about their students, they tended to assume little responsibility for their own instructional choices; instead citing students as the reason for employing more traditional instructional practices rather than the reform-based practices they learned in their preservice teacher preparation. Their discourse is one of being forced or having no choice as to what they can do because their "type" of student, mainly discussing students that are lower in academic ability and from minority and/or low socioeconomic backgrounds, can't handle any instruction that is not direct, concrete, or full of explicit directions.

This type of deficit-oriented discourse was absent from Matthew and Stephen's descriptions of their students. In discussions of student learning, these two high practice teachers did not partition out whom their reform-based instructional practices were for, rather they spoke of all their students as a collective. Matthew spoke inclusively of his students when he described his perception of how they learn best. He stated:

I think my students also learn best by knowing that I am a competent teaching who kinda knows what they're doing, and who is a fair teacher. Um, and then having interesting learning activities that they don't feel is just seat work or is just a waste of their time or is just, um, made up. I like to try to make things authentic or, um, real experiences when I can. So, I think –I think that's how they learn the best. So, by having those, plus actually doing their own work and asking and answering their own questions, I think is the best.  
(Beliefs Interview, 2008)

Matthew description of student learning and his instructional practices applied to all his students, regardless of teaching students of various abilities. He also expressed being responsive to the needs of his students rather than perceiving students' abilities as factor in altering what he

believed to be the most effective instructional practices. When he first began teaching, he was initially surprised by how diverse his students' abilities levels were, teaching both "high end students" and "really low skilled students" (Introductory Interview). In response to teaching across a wide range of student abilities he described the need to "be patient with students of different abilities" (Introductory Interview) and the need to focus on goals for each student or to have a "heighted level of attention for each student" regardless of their abilities (RoPPE Interview). The attention to the individual needs of all students, and the inclusive discourse regarding the instructional practices necessary for all students to learn science, combined with the notable lack of a deficit-oriented discourse set Matthew and Stephen apart from the other teachers with regards to how they viewed their students.

### **Summary Local Context**

Analyzing the contexts into which these six teachers were socialized as new science teachers provided data related to several themes that highlighted how experiences, and key individuals within these contexts, shaped different socialization experiences for teachers based on their level of practice. These findings related to school context are aligned with research that indicates the workplace in which teachers are socialized has considerable impact on their teaching practices (Grossman et al., 2000; Ziechner & Gore, 1990). The data analysis showed teachers' perceived level of professional autonomy differed among the low/mean practice teachers and the high practice teachers. Low/mean practice teachers expressed little autonomy for making curricular and instructional decisions; feeling no control over these areas of their professional role. Teachers expressed feeling forced into using certain activities regardless of their professional opinion about their worth. The high reform-based practice teachers experienced a much different level of professional autonomy, expressing having control over

many aspects of their professional teaching tasks. These two teachers described working in an environment where they perceived having flexibility in their curriculum, and decision making authority. Viewing teacher socialization in the school context as a process of negotiating power, Edgar and Warren (1969) describe that the interplay between who has control and autonomy in the workplace influences teachers' job satisfaction, particularly in relation to having autonomy for decisions regarding teaching methods and curriculum. In this study, administrators and teaching colleagues influenced the differing levels of autonomy experienced by these two groups of teachers. Low/mean practice teachers described how relationships with administrators inhibited their professional autonomy. High practice teachers described the respect and support from administrators to function autonomously, without pressure to conform to the practices of those around them enhanced their feelings of professional autonomy. This is akin to previous research detailing just how much the power dynamics during teacher socialization experiences with administrators' impacts teachers. The degree to which administrators wield their political power, or interfere with teaching decisions or pressure teachers to conform, can lead to less job satisfaction regarding the ability to develop a personal teaching style (Edgar & Warren, 1969) and can influence the realization of reform-based teaching practices (Windschitl, 2002).

Most teachers did not value their professional development activities; they found them boring, and too general, or not relevant to them. The teacher with the highest level of reform-based teaching was the only teacher to express overly positive views regarding their professional development. He perceived having a choice in his professional development, and found it relevant to his needs.

The culture of support from colleagues and administrators differed among the low/mean practice teachers and the high practice teachers. All teachers discussed being part of a supportive

peer culture, but the nature of the support experienced varied. While all six teachers discussed colleagues that provided procedural or practical support, only the high practice teachers expressed support for instructional decision-making. High practice teachers discussed a culture of collaboration amongst colleagues that aided them in sharing and implementing new instructional strategies. As outlined by prior research, this type of culture, specific to these two teachers schools, influenced their socialization as a teacher contributing to and influencing how they view their role, function, and contribution to the school community (Cherubini, 2009). In the absence of this type of culture of support, the dominant school culture in which teachers are socialized push teachers “towards practices in which the teacher is in more control of the learning environment” (Windschitl, 2002, pp. 150-151). The high reform-based practice teachers also expressed a greater sense of support from their administrators than those with low/mean levels of practice. Along with support, teachers differed in how well aligned they felt with their administrators philosophies of education. High practice teachers perceived a degree of fit between their ideals and those communicated by their administrators. The other teachers with lower levels of practice did not experience this same degree of fit, sometimes strongly disagreeing with their district administrators’ focus. These teachers appear to be using what Lacey (1977) described as a strategic compliance strategy. They comply with mandates of district administrators and or colleagues even though they express reservations about these demands and approaches to teaching.

The final aspect of the local context that varied among the low/mean practice teachers and the high practice teachers was their perceptions of how students’ influenced their instruction. These findings align with prior research indicating the important role students play in the process of teacher socialization (Zeichner & Gore, 1990). Though all teachers had a desire to help all



students, some teachers expressed feeling reform-based practices were not suited for all students. Low/mean level practice teachers often engaged in a deficit oriented discourse regarding their students, viewing students ability, backgrounds, behavior, and motivation as hindering their ability to be engaged in reform-based instruction. This seemed particularly evident when teachers were teaching students of different racial and socioeconomic backgrounds than themselves. The discourse of these four teachers implicitly held students responsible in part for the lack of success in implementing these strategies. This type of discourse about certain types of students' inability to engage in reform-based practices was absent from the high practice teachers descriptions of their students.

### **State Policy Environment**

#### **Teachers' Sense of Agency Related to Their Perception of the State Curriculum as Either a Driving Force for What to Teach or as a Guide Informing Their Teaching**

All six teachers in this study described their state curriculum as having an influence on their teaching; however the nature of this influence varied between the low to mean practice teachers and the high practice teachers. The teachers who enacted low to mean levels of reform-based instructional practices portrayed the state curriculum as the driving force for what to teach and often how they taught. One major concern expressed by many of these teachers was the state curriculum contained too much content to adequately cover in the course of a school year. Alexander spoke in length about trying to get a handle on the amount of content he was expected to teach for biology. Frustrated by this curriculum he stated, "Um, I really hate the biology curriculum. Um, the way it's laid out and the State guide and the way the county wants us to teach it" (RoPPE Interview). He began keeping a notebook to detail the standards and vocabulary that he would need to cover. At the time of the study, he had amassed a list that

topped over 327 new vocabulary terms he had to include in his instruction. He described how this influenced his planning for instruction focusing his efforts on trying to maximize his time to include everything stating, “But, it’s all driven, now, by my notebook. I...Even when we start a unit...I take my objectives and...put it into student form” (Beliefs Interview, 2008). Heidi also expressed the driving influence her state curriculum had on what she taught stating it was, “pretty well laid out for me.” However, unlike Alexander, this did not bother her as much as she saw the information included as valid for high school chemistry students stating, “Although, however, like, what’s in there I would teach, because it’s all, like, the stuff that’s in the standard. Like, I mean, I’ve been told what to teach, but it all makes sense” (Beliefs Interview, 2008). Though she did not object to the content of the state curriculum, she found it drove everything she taught stating, “And there’s pretty much no room for anything else. Chemistry is pretty...filled” (Beliefs Interview, 2008).

The teachers with low to mean levels of reform-based enactment felt the level of content contained in the curriculum controlled the pace of their instruction. Amanda found this to be highly unrealistic for her to manage in the time allotted to her to teach. She commented:

But I don’t have an hour a day that I can do that with the pacing guide with what they expect me to teach them in the certain amount of time for the EOC. It’s just not realistic. What they want us to do is not realistic to what -- how they’re telling us to do it. (RoPPE Interview)

Alexander also expressed these sentiments stating, “I’ve lost a good part of them. But, I can’t slow down” describing how the amount of content and the pacing guide drove him to continue to teach even if he knew students did not understand the material (Preservice Interview). Mark also

found that he had little to no flexibility in the pace of his instruction due to the need to cover the entire curriculum by the end of the year. He stated, “basically, the time I schedule is the time I schedule. If they get it, or the kids don’t get it” (Beliefs Interview, 2008). Due to the pressure to fit everything in, Mark found that his only avenue for helping students who did not understand was to continue to “embed the topics throughout the course.” For Mark, not only did he feel a lack of control over the pace of his instruction, but also felt the state driven courses did “not allow sufficient investigation, of the nature of science” (RoPPE Interview). This lack of flexibility in the pace of instruction detailed by these teachers left them feeling like there was no room for re-teaching if students did not understand the content. Teachers described frustration with this pace as it negates the use of formative assessment for instructional planning. Amanda comments reflected this:

Okay, yes, I can do a formative assessment; use my RIO test or whatever they want me to give as a formative assessment. And say, hey, this kid does not know, you know, um, food chains. But, I’m supposed to stay on this pacing guide that doesn’t allow me any room to take a day to re-teach him food chains.... It’s like, when I am supposed to do this extra, you know, remediation for him. (RoPPE Interview)

Similar to the other teachers, Amanda found that providing this “remediation” was not possible in her classroom setting. Yet, she found that for reasons due to transportation and student employment, she wasn’t able to provide this kind of support beyond the school day.

The two teachers with higher levels of reform-based practices operated within a state curriculum as well. However, their discourse about the way in which this curriculum influenced their instruction was different than the other teachers. While there were still elements of talk

regarding the structure that the state curriculum imposed on their instruction, Matthew and Stephen's remarks centered on how the state curriculum informed what and how they taught, rather than drove how they taught. Though there are still aspects of their science curriculum that were not in their control, Matthew and more so Stephen's discourse reflected a sense of agency for making instructional decisions in light of the state curriculum mandates. Matthew described how the curriculum was already mapped out by the state, but he still felt he could add his own touch to the curriculum. He stated:

Well, I'm governed – since I teach all earth science courses this year, I'm governed by the State, um, curriculum. But then I like to add, um, my own embellishment on those things. And, I also like to add in things that I'm interested in, too" (Beliefs Interview, 2008).

In addition to feeling he had the capacity to embellish the state curriculum, he viewed the curriculum as not taking away his ability to have his own instructional style as a teacher. Matthew commented that in his desire for students to be successful in earth science, "I try to model learning experiences based on what is required by State guidelines, and I try to use my own artistic and, um, my own expression to pass those along to my students" (RoPPE Interview). Matthew's perception was that "other than making sure that I cover the required material, that doesn't really influence how I teach" (RoPPE Interview). He did describe having "a timeline" that worked well for him to ensure he covered the entire state earth science curriculum during the school year. Unlike some of the other teachers, Matthew did not describe his timeline as concrete, feeling he had the ability to be flexible and responsive to student understanding of content. He stated:

Um, that's not a calendar that's written in stone, it's just my guideline, and I try to make sure that my students are meeting my objectives. And through assessments and what we talked about earlier, are the students behaving, are they enjoying, um, are they questioning and answering, then I know it's time to move on. (Beliefs Interview, 2008)

Matthew allowed students to help determine when to move on to another topic, rather than a more rigid approach to adhering to a schedule. Stephen also shared Matthew's view of the capacity he had to make decisions about when and how much to include from the state curriculum into his timeline for teaching. As other teachers shared, Stephen also expressed concern about how much time he had to teach all the concepts in the state curriculum. He commented, "Unfortunately part of it is decided by time. You do have a certain amount of things that need to be addressed over the course of the year and you only have so much time to do it" (Beliefs Interview, 2008). Though restricted by a certain number of weeks in the school year, he felt he still had choice in deciding what was essential to teach. Stephen commented on this process stating, "So, which parts do they really not need to know and which parts do we think are essential and that's where the creativity and the teachers get to actually get to decide what's going on and that's the fun part" (Beliefs Interview, 2008). This view that he was able to be creative and have fun with curricular decisions despite the time constraints was markedly different than the four previously described low/mean practice teachers' views. Stephen believed it was within his capacity to reserve instructional time for important things that would not otherwise be introduced. He also did not feel pressured to proceed to a new topic without assessing student understanding. He commented:

What needs to be taught and what could be left out, what's the most important things for this year. That is the first expressed issue, were not a chapter a week type school we give them plenty of time on every topic. (Beliefs Interview, 2008)

Matthew and Stephen described experiencing similar state curriculum contexts as the other four teachers, but perceived having authority to make adjustments to the curriculum based on their creative professional judgment as well the ability to use student feedback to determine when to proceed in their instruction. These perceived abilities reflected a sense of agency as professional teachers that appeared to be lacking in the other four teachers.

### **Pressure on Teachers From District Response to State Testing Policies**

All of the teachers, except Stephen, taught a class that had a required state exam at the end of the course. In many instances, these teachers expressed their districts' response to these state examinations was to impress upon teachers that their number one professional priority was to raise student scores. Mark described this message from district administrators regarding state exam scores, "That are the all-important thing! Beyond that, everything else is secondary" (RoPPE Interview). Generally this type of district message regarding student state test scores conflicted with what the teacher viewed as important to their role as teacher. As previously mentioned, Mark disagreed with the lack of importance his administrators placed on preparing students to work in the sciences and be scientifically literate. Instead he perceived that they were consumed by student success as measured by test scores. He stated:

I think a lot of it is driven by our End-of-Course testing. Because, the only thing that the administration's concerned about, or that the teachers are concerned about is, "Do my kids do well on this EOC or not?" Everything else is secondary. If they don't remember

stoichiometry two years from now, or the basics of chemistry two years from now, it doesn't matter...as long as they do well on the EOC. I think it's a terrible injustice, what they've done at the elementary level...essentially taking science out of the curriculum! Because, the EOG's [End-of-Grade tests] don't test the sciences at that level. So, it's just the district's policy's absolutely horrible! I would never send my child to public school, because of that. Or, that's part of the reason. (Beliefs interview, 2008)

Mark's frustration with his district's reaction to the demands of the state examinations lead him to feel as though injustice was being done to the students so much so that he could not imagine sending his own children through a similar public school. Mark also indicated that the only reason he received support in terms of resources for teaching was because he was "teaching an EOC course" stating that "if I can say the magic words of, 'It'll help on the EOC,' Um 90% of the time, I'll get 'em. And, so it shouldn't be like that" (RoPPE Interview).

Several other teachers' expressed a district focus on test scores and the contention they had with the pressure they experienced as a result. For example, Alexander described the only way to get his boss to "lay off" was to have his students do well on the multiple choice EOC test. Heidi also described a similar scenario in which her district officials impressed upon teachers the need for teachers to solely focus on bringing up the state examination scores, in this case the Regents exam.

Um, that's pretty big. There's a big push with the Regents. Last year, um, scores were not very good on Regents over all. And, um, there's been a huge thing. Like, this year, they told us, we don't care what you do, but, like, teach to the test, pretty much. They're

like, we need our numbers to be higher. So, they basically told everybody, you need to teach to the test. (RoPPE Interview)

As Heidi described above, she felt explicit pressure from her district administrators to “teach to the test”, or focus her instruction on how to best get students to pass the kinds of questions that are typical of the Regents exam. In many instances, teachers described ways in which the pressure to improve their students’ scores on state exams influenced their instructional actions in the classroom. The most common way in which these teachers adjusted their instruction in light of the state exam pressure was to incorporate more multiple-choice questions into classroom assessments, and spend instructional time coaching students to practice multiple-choice questions. Amanda commented on this aspect of her instruction stating:

So, but the kids that really work really hard in here still struggle with EOC, because they struggle with multiple choice questions. So, I’ve been throwing out, like their warm-up multiple choice questions, their ticket multiple choice questions, their homework Monday, multiple choice questions. I’m like, you know, if that’s how you’re going to test them, and you’re going to test their knowledge, I’ll teach them the information and that’s how I’m going to, you know, assess the, you know. (RoPPE Interview)

Alexander also held the same perception that the need to bolster student achievement on state exams necessitated that he instruct them on how to best answer multiple-choice questions stating, “I feel that there’s such a high-stakes multiple choice test at the end that if I don’t get them thinking multiple choice so that they’re able to do that...Then, I’m letting them down” (Beliefs Interview, 2008). Often teachers’ instructional decisions to practice exam or multiple-choice questions were not based on content understanding, but on a mastery of how to best approach



multiple-choice questions. Heidi illustrated this point stating the students' problem was, "They have trouble, like, decoding what they're actually asking. So without practicing, I'd be doing them a huge disservice going in" (RoPPE Interview). Even one of the high level practice teachers, Matthew, described this influence to his practice stating "I think that the way the State's – the State tests are written – I think this applies – I think the way those are written, students need to practice those" because "I find the students know the content of science, but then can't necessarily reproduce it on a test" (RoPPE Interview). Matthew explained while he used to think that this was not as important, he now incorporated test-taking strategies into his instruction. For many of these teachers already feeling pressed for time to teach all the content in the state curriculum, their sense of obligation to take time away to improve their students' test-taking skills contributed to an even more rushed pace of instruction.

Stephen was the lone teacher whose course did not require an end of course exam. He was keenly aware of what other teachers in his district felt as a result of state exams and felt lucky the influence of exams is insignificant for him as he stated, "that hasn't touched me too much" (RoPPE Interview). He described that this current freedom to teach what and how he wanted would change if they added an exit exam for his course. He stated:

Thankfully, chemistry doesn't get tested in this field at least not above a physical science level of chemistry. So we have freedom but if they instituted a 12th grade exit exam that test in chemistry we would be held to a much more stringent curriculum. (RoPPE Interview)

The lack of pressure to prepare students to pass end of course state exams in his class offered Stephen more choice over his course planning and instruction. Stephen expressed uncertainty

about how he would respond to the pressure of state exams in his class. He stated if he were in that situation he would be concerned about how he would “make the class the way that you want to and still have them be prepared to be successful on the test. How many liberties can you take and how many can you not take” (RoPPE Interview). These are in fact the real concerns the other teachers dealt with, often feeling a lack of authority to take any liberties in their teaching.

### **Summary State Policy Environment**

The last level of analysis looked at the teachers’ descriptions of the state policy environment in which they functioned as a teacher, and the related ways being socialized into the environment influenced their instructional practices. There were several differences between how the low/mean level teachers and high practice teachers described the influence of state curriculum on their practice. Low/mean level teachers perceived the state curriculum as a driving force for what to teach and how often. They expressed frustration that there was too much content to cover, and the timeline to teach it was so rigid that they had no time to slow down and assure student understanding. The high practice teachers operated within similar constraints of the state curriculum, but expressed a sense of agency for making instructional decisions, feeling the state curriculum informed what they taught rather than drove all instructional choices. These findings align with research on teacher socialization indicating teachers’ classroom practices and their perceptions regarding constraints on their practice are partially a result of state policy related influences such as the state curriculum (Zeichner & Gore, 1990). The teachers in this study with a greater sense of agency did not experience the curriculum policies as a constraint due to a more autonomous and supportive socialization into their school districts.

All but one of the teachers taught a course with a required end of course state examination. Teachers' perceptions regarding their districts responses to these required exams influenced choices they made in their teaching. Many teachers expressed their districts placed a priority on improving state exam scores above all else. This did not resonate well with these teachers who felt that kind of pressure constrained their instruction. As teachers are socialized into the school context, the way in which the district responds to accountability policies influences teachers' practice. These findings are in line with teacher socialization research which indicates teachers will relinquish instructional practices aligned with their own ideas of effective teaching for those that they believe will ensure students pass state tests (Cherubini, 2009; Ogawa, Sandholtz, Martinez-Flores, & Scribner, 2003). Though the teachers in this study were already concerned about their timelines for teaching all the content, they found it necessary to include instruction related to test-taking strategies and altered instruction and assessments to provide more practice on multiple-choice questions. The degree to which teachers' socialization into the school context is driven by worry to conform their practice to the broader district mandated goals of meeting state accountability measures, the more teachers practice may assimilate to those that are dominant in school culture (Cherubini, 2009; Windschitl, 2002). Stephen was the lone teacher in this study who felt free of these concerns due to not having an exam for his course, but he recognized other teachers in his school teaching courses with exams experienced these same pressures.

### **Chapter Five Summary**

This chapter presented the qualitative data analysis from phase two of this sequential mixed-methods study. Instrumental multi-case studies were used to further understand how factors identified in the first phase of the study related to teachers' personal backgrounds, local

school contexts, and state policy environments contributed to explaining the differences in levels of reform-based science teaching exhibited by graduates from three reform-oriented teacher preparation programs. These case studies of six secondary science teachers, chosen to represent low, mean, and high levels of implementation of reform-based instructional practices, provided an in-depth examination of teachers' views regarding influences to their socialization into the teaching profession and their pedagogical practices. Throughout the development of the cases, and in the cross case comparison, it became evident the teachers with low and mean levels of reform-based teaching practices were more similar to each other than not in their descriptions of practice as well as the descriptions of the experiences that influenced their practice. What emerged was a dichotomous comparison of the low/mean practice teachers and the high practice teachers. Data analysis presented in this chapter included themes derived from multiple sources of interview data for each case teacher, obtained from an existing dataset from the IMPACT Project. The findings were organized and presented according to three main spheres identified by Achinstein, Ogawa, and Speigman (2004) as influential to the socialization of teachers and their developing instructional practices: (a) teachers' backgrounds, (b) local contexts, and (c) state policy environments.

There were several aspects of teachers' backgrounds that differed between the low/mean practice teachers and the high practice teachers. Several characteristics and experiences from teachers' personal backgrounds were widely similar. All six teachers shared a common experience in their college science content preparation; coursework heavily reliant on lecture/note based instruction, lacked cooperative group activities, and focused on content memorization. Each teacher shared similar stories of the best/worst teachers they encountered as science students. These experiences helped to shape their visions of good science teaching

regardless if they were able to enact these visions. What distinguished the high practice teachers from the low/mean practice teachers was the difference in scientific research experiences. High practice teachers far exceeded the low practice teachers in the amount and types of research experiences they had that were beyond the scope of their normal degree requirements.

With regards to teachers' professional backgrounds, there were many differences between these two groups of teachers as well as between the different degree program graduates. All teachers enjoyed their preservice teacher preparation program, particularly their methods courses which had very similar features. However, the overall perceived quality of their preparation varied among the graduates from the three different preparation programs. The perceived quality of the program was linked to the structure and duration of field practicum experiences. Graduates from NCSU, who had the least amount of hours in the field, expressed the most dissatisfaction feeling underprepared for the realities of the classroom. Though they had desired more time in the field, they were overall positive, as were all the teachers regarding their student teaching placements. Teachers took away similar lessons from their host teachers, incorporating and imitating their host teachers' approaches for procedural and managerial aspects of teaching. The high practice teachers varied in that in addition to this they also described taking away teaching practices focused on the students' needs and learning. Overall, what teachers valued most from their preservice teacher preparation differed between the low/practice and high practice teachers. The low/mean practice teachers expressed finding value in acquiring resources and skills for teaching, apart from the theories of teaching and learning. Though the high reform-based practice teachers also valued these things, they strongly valued taking away a research-based understanding of their practice, and seeing the theories of teaching and learning applied in their practice. While all teachers liked their preservice preparation, the

graduates from NCSU felt underprepared and often wrestled with a divide between the theories learned in their preparation and the reality of their classrooms. SU and UI graduates expressed a high sense of preparation.

With regards to the local context in which these teachers were socialized, low/mean practice teachers varied greatly from the high practice teachers in their perceptions of their level of professional autonomy, the culture of support from colleagues and administrators, and their views regarding the influence of students on their instruction. Low/mean practice teachers expressed having little autonomy for making curricular and instructional decisions and felt forced to use previously developed lessons against their professional judgment. These teachers indicated that their colleagues and administrators contributed to suppressing their autonomy. The high practice teachers described feeling very autonomous in their teacher role, having flexibility and decision making authority in their curriculum. This level of autonomy was fostered in part by the support of administration and colleagues. Regardless of their perceived level of autonomy, all teachers described feeling supported by their administration or colleagues in some capacity. Low/mean practice teachers expressed this support in the form of procedural or administrative support. In addition to feeling this kind of procedural support, high practice teachers also experienced support directly related to implementing various instructional strategies. The high practice teachers experienced a high degree of fit between their ideals and those of their administrators, while the low/mean practice teachers often experienced a divide in this area. Finally, what was notably absent from the high practice teachers' discourse was the notion of delimiting reform-based instructional practices for certain students. Low/mean practice teachers often engaged in a deficit-oriented discourse regarding students' abilities, backgrounds, behavior, and motivation levels as determinants of whether or not they could implement reform-

based instructional practices. This discourse appeared to be driven by these teachers being socialized to teach in districts where the student populations were of different racial and socioeconomic backgrounds than the teachers.

The final sphere of influence to teachers' socialization analyzed in this chapter, the state policy environment, revealed more differences between the low/mean practice teachers and the high practice teachers. Though all teachers operated within a state curriculum with guiding standards, the low/mean practice teachers perceived this curriculum to drive what and how they taught. These teachers expressed not having enough time to cover the content and ensure all students reached a solid level of understanding. Within the same confines, the high practice teachers expressed having a sense of agency for instructional decisions, feeling informed by the state curriculum rather than driven by it. End of course state exams were present for all but one teacher, whose state did have end of course exams, but his course did not require it. The teachers expressed that the priority their districts placed on bringing up students' state exam scores put pressure on their instruction. The greater this district message was, the more teachers felt despondent about their ability to implement what was learned in their preservice teacher preparation. These teachers modified their instruction to include teaching students' content as well as test taking strategies to help boost test scores.

## CHAPTER SIX: DISCUSSION

### Overview

The purpose of this sequential explanatory mixed-methods study was to explain the range of reform-based teaching practices enacted by secondary science teachers who were graduates of three reform-oriented teacher preparation programs. This study viewed instructional practices as one product of teachers' socialization into their professional roles as teachers. As such, the present research focused on key components of the socialization process that contribute to the development and enactment of a teacher's pedagogy. Recognizing that the process of teacher socialization begins prior to formal teacher preparation and extends across a varied landscape of formal preparation as well as local and state contexts, this study aimed to assess the relative impact of these various components using both quantitative and qualitative data from an existing data set collected during the IMPACT Project, a five-year mixed-methods study funded by NSF involving the collaboration of Syracuse University, the University of Iowa, and North Carolina State University.

In the first quantitative phase, data collected from three surveys of secondary science teachers were utilized in a hierarchical multiple regression analysis to determine the separate as well as the combined relative influence of secondary science teachers' characteristics, backgrounds, and experiences across their teacher development to explain the range of teaching practices enacted. The findings from phase one of this study guided the selection of the sample as well as the analysis of data in the second qualitative phase. Phase two of this study used case studies of six teachers to further explore aspects related to teachers' use of reform-based teaching practices. Data drawn from multiple interviews with the case study teachers were analyzed to understand teachers' views regarding influences on their socialization into the teaching profession and the impact on their developing instructional practices.



### **Summary of Integration of Quantitative and Qualitative Results**

The study utilized a mixed-methods design to facilitate both “breadth and depth of understanding” the research problem (Johnson, Onwuegbuzie, & Turner, 2007, p. 123). As noted in Figure 4, findings from both the quantitative and qualitative phases of the study are integrated here in the discussion chapter to aid in explaining the variation in teachers’ use of reform-based teaching practices as a function of their socialization into the teaching profession. A mixed-methods design like this allows for the “findings from the second, qualitative, phase to further clarify and explain the statistical results from the first, quantitative, phase” (Ivankova, Creswell, & Stick, 2006, p. 14). This section will present a brief summary of the results of each phase of the study. These findings will then be discussed jointly to highlight the salient findings from each sphere of influence that are important to the socialization of teachers and that help to explain teachers’ enacted instructional practices.

The full hierarchical multiple regression model was statistically significant, explaining nearly 38% of the variation in secondary science teachers’ use of reform-based instructional practices. To assess the contributions of different spheres of socialization influences impact on teacher practice, variables were blocked and entered in five steps. Three of these five steps contributed significantly to the model: a) teachers’ professional backgrounds; b) teachers’ beliefs and efficacy; and c) the local context of teaching. The five variables within these blocks that significantly contributed to explaining this variation were 1) the university of teacher preparation from variable block two, teachers’ professional backgrounds; 2) the sense of preparation for teaching science from variable block three, teachers’ beliefs and efficacy; 3) quality of professional development from variable block four, the local context of teaching; 4) the degree to which professional development was science content focused from variable block four, local

context of teaching; and 5) the level of professional autonomy from variable block four, local context of teaching. This regression analysis provides evidence that both teacher preparation and the local context of teaching contribute to teachers' instructional practices, which refutes the notion that teacher preparation is "washed out" (Zeichner & Tabachnick, 1981, p. 9) and extends the work of other researchers by providing additional support showing that certain aspects of teacher preparation are influential in combating the occupational socialization of the school environment (Brouwer & Korthagen, 2005). The additional significant contribution of the local context step of the regression model further supports research that suggests the school context in which teachers are socialized impacts the kinds of practices they take up (Zeichner & Gore, 1990). Teachers' personal backgrounds and the state policy environment were not found to significantly contribute to the model. Discussion of limitations to the model will be discussed later in this chapter.

The second qualitative phase of this study used six teacher case studies to enhance the understanding of the significant findings from the first phase of the study. According to Ivankova, Creswell, & Stick (2006), secondary qualitative data and analysis in a sequential explanatory mixed-methods design is used to "refine and explain those statistical results by exploring participants' views in more depth" (p. 5). The cross-case analysis provided insight from the teachers' perspectives, further explaining how the five significant variables related to teacher preparation, teacher efficacy, and local context in explaining the level of reform-based practices teachers implement. The quantitative results provided evidence that, generally, the nature of the teacher preparation program was influential in explaining the variation in practice as teachers who were graduates of the University of Iowa teacher preparation program used more reform-based teaching practices than teachers from the other two universities.

Qualitative analysis identified four themes related to teacher preparation that helped to explain more specifically the differences in teachers' experiences in these teacher preparation programs: 1) teachers found common ground in their descriptions of the science specific methods courses of their teacher preparation program; 2) teachers' perceived quality of their teacher preparation was linked to amount of practice in the field; 3) teachers' modeling their practices after lessons learned from host teachers during student teaching placements are either focused on procedural aspects for planning and maintaining control of the classroom or on pedagogy; and 4) take away lessons from teacher preparation varied according to their level of practice - that is, teachers with lower levels of reform-based practice viewed teaching as the acquisition of resources and skills, while high reform-based practice teachers developed a research-based understanding of teaching. The significance of teachers' sense of preparation for teaching science was further explained by the cross-case analysis, which revealed that teachers' sense of preparation to teach science was linked to perceptions of their teacher preparation program's ability to prepare teachers for the "real" classroom. Statistical analysis of phase one indicated that the local school context influenced teachers' practices. The quantitative significance of the level of professional autonomy on teachers' reform-based practices was further supported by the qualitative analysis. This analysis revealed that, among teachers exhibiting high levels of reform-based teaching practices, greater feelings of professional autonomy were experienced, particularly through the influence of both administrators and colleagues. Finally, teachers who experienced quality professional development as well as more science content focused professional development reported greater use of reform-based instructional practices. Though the qualitative data was limited with regards to these variables,

most teachers perceived the structure and content of their district provided professional development to be inadequate.

The qualitative analysis also helped to extend understanding of the variation in teachers' practices beyond the quantitative model. The phase two analysis helped to fill some of the gaps in the model pertaining to the personal backgrounds of teachers and early socialization experiences, for which there was no quantitative data. Three themes emerged relating to teachers' experiences prior to formal teacher preparation: 1) experiences in college science coursework were similar for teachers across all levels of reform-based teaching practice; 2) the quantity and quality of teachers' scientific research experiences were associated with teachers' level of practice; and 3) teachers' best and worst experiences as a science student shaped visions of good teaching, regardless of whether these visions were enacted. With regard to the local school context, three additional themes emerged beyond those related to the statistically significant findings: 1) while most colleagues are perceived as supportive, the nature of this support is important for teacher practice; 2) the degree of fit perceived by teachers was associated with philosophical alignment with, and support from, the administration; and 3) most low to mean practice teachers suggest students' abilities and backgrounds thwart their ability to implement reform-based practices. Finally, the statistical analysis did not find the policy related variables to be significant. However, the qualitative analysis identified two themes related to differences in teachers' practices: 1) teachers' sense of agency related to their perception of the state curriculum as either a driving force for what to teach or as a guide informing their teaching; and 2) pressure on teachers from district response to state testing policies. These qualitative findings extend the significant quantitative findings. They will be discussed in relation to the specific limitations of this study and in light of how they might further refine future research

investigations. The following discussion section will expand on in greater detail the results presented above, both those that support the quantitative findings and those that go beyond the model.

## **Discussion**

As indicated above in the summary of the phase one and phase two results, this study revealed several significant findings regarding influences on teachers' enactment of reform-based instructional practices. The discussion of the findings will be organized and presented according to the three main spheres of teacher development that research has identified as influential to teachers' socialization and eventual classroom instructional practices: (a) teachers' personal and professional backgrounds; (b) local contexts; and (c) state policy environments (Achinstein, Ogawa, & Speiglmán, 2004).

### **Teachers' Personal Backgrounds**

This study sought to understand how factors related to teachers' personal backgrounds, the influences to their teaching prior to their formal teacher preparation, help to explain their eventual classroom instructional practices. It is well regarded that the process of teacher socialization begins prior to formal teacher training, and the "formative experiences" of a teacher's personal background partially contribute to the products of teacher socialization (Zeichner & Gore, 1990). Woodbury & Gess-Newsome (2002) also noted the importance of teachers' personal factors in that they "influence teacher thinking and practice, and therefore ultimately reform efforts" (p. 774). Phase one of this study was limited in the analysis of factors related to teachers' personal backgrounds. Teacher' race and gender were entered to account for how these factors might contribute to their worldviews (Achinstein, Ogawa, & Speiglmán, 2004) as well the level of science content knowledge they brought to their teacher preparation program.

None of these variables were significant in the model explaining variation in teaching practice. There are only a small number of large scale quantitative research studies related to the impact teacher background variables have on explaining teachers' use of reform-based science teaching. Of this limited research, teacher race and gender have not been strongly associated with use of reform-based practices (Smith et al., 2007) and were omitted in the analysis of middle and secondary science teachers' practices conducted by Smith, Banilower, Nelson, & Smith (2013). However, in the analysis of eighth grade science teachers' use of reform based practices, Smith et al. (2007) did note that female teachers stressed more reform-based activities than did male teachers. These authors also concluded that Black teachers emphasized more conceptual goals for science teaching and indicated a higher use of reporting and writing activities than White teachers. Previous research has found science content knowledge (as measured by participants having a degree in science) to be predictive of using some aspects of reform-based science teaching practices by middle school teachers (Smith et al. 2007, Smith et al., 2013); however, this did not hold true for high school science teachers (Smith et al., 2013). Prior research is inconclusive with regards to if and how these variables predict the enactment of reform-based science teaching. The findings of the present study add to this research base indicating these variables were not predictive of secondary science teachers' enactment of reform-based instructional practices, though teachers' level of content knowledge may still need refinement in how it is operationalized to more deeply understand the relationship between science content knowledge and instructional practices.

However the qualitative data analysis added more depth of understanding regarding the contribution of teachers' personal backgrounds to understanding teacher practice. It is not surprising that the amount of content preparation (measured in number of courses) was not

significant as the qualitative descriptions of experiences as a student in college science coursework were very similar, across all levels of implementation of reform-based practices. These six teachers recalled spending a majority of time in their college science courses as passive learners in typical lecture and PowerPoint oriented classes. To a large extent, the focus of their science coursework was on content acquisition with little emphasis on skill development and understanding the processes of science, even in the laboratory sections of their science courses. These types of college science experiences are not uncommon; rather, they represent the norm of what is typical of undergraduate science pedagogy. In an analysis of nearly 400 undergraduate laboratory activities, Buck, Bretz, & Towns (2008) found a majority of the experiments were “highly structured” engaging students in little to no scientific inquiry. Windschitl (2003) notes a great deal of what teachers learn about teaching comes from these courses and models provided to them of laboratory experiences which are mostly confirmatory in nature.

The qualitative phase of the study also found the teachers’ positive and negative experiences as science students shaped their visions of good teaching regardless of whether they eventually enacted these visions of science teaching. This finding is consistent with previous research indicating the construction of teachers’ personal knowledge related to teaching and their visions about good teaching is often based on their experiences as students (Beijaard, Meijer, & Verloop, 2004; Darling-Hammond, 2006; Eick & Reed, 2002). The teachers in this study were more frequently exposed to models of science teaching that did not reflect reform-based science teaching. The fact that four of the six teachers went on to enact some of the same types of instructional practices they had claimed were the opposite of “good teaching”, recreating the practices from their negative role models, suggests the strength of the implicit influence of these

early role models on teachers' eventual classroom practice, continuing the legacy of more traditional science teaching pedagogy typical of their own experiences as a student. In light of research on teacher socialization this makes sense given that teachers spend years both in their K-12 and undergraduate science career in an "apprenticeship of observation" taking in various cues about the practice of teaching (Lortie, 1975). Windschitl (2004) extends this theory of early teacher socialization to science teachers, noting that "preservice teachers develop a host of ideas about doing science, constructed over years of schooling, and prepare themselves to continue various aspects of this legacy with their own students. The most recent and most involved of these science experiences often come from their years as undergraduates" (p. 485). These early socialization experiences may influence how teachers experience and what they can learn from their teacher preparation (Feiman-Nemser et al., 1999; Feiman-Nemser, 2001).

Teachers' in this study valued their science teachers who were personable and fun and whose pedagogy extended beyond lecturing, making the content applicable to the real world, involving students in conducting and presenting research, and who pushed for students to process information rather than focus on factual memorization. The six teachers in this study incorporated these ideals into their visions of good teaching, yet only the two high practice teachers approached realizing these ideals in practice. The low/mean practice teachers described their practice in ways that mirrored the kinds of experiences they pushed back against as students and hoped to avoid as a teacher. Rather than modeling their behavior after the visions of good teaching, their practice become more like the composite of their "worst" science teaching experiences: lacking the ability to relate or interact effectively with students; relying on less appealing instructional practices, such as lecture and note taking; focusing on content memorization; and moving through content material at a rapid pace in order to cover everything



deemed necessary. This contrasts with previous research in which some teachers were found to use more reform-based teaching practices because they were motivated by their negative experiences with traditional teaching practices that were most common to their learning experiences (Eick & Reed, 2002).

The most compelling difference related to teachers' personal backgrounds was the difference between the quantity and quality of their scientific research experiences outside the normal requirements of their undergraduate degree program. Teachers who reported low/mean levels of reform-based instructional practices indicated they had either little to no scientific research experiences beyond their undergraduate laboratory courses. Of these teachers that did have some minor independent research experience as a part of their undergraduate degree program, they reported minimal participation in the design and analysis of the research, with their primary involvement being relegated to more low level tasks. The two high practice teachers had extensive research experiences that they sought out beyond the scope of their degree requirements. Throughout these research experiences, these teachers felt integrated into the research projects, collaborating with faculty and graduate students, which provided them with the circumstances to develop the skills and processes of science. In addition, these research experiences may have also helped these two teachers develop a "functional understanding of the nature of science (NOS)" which refers to "the epistemology of science, science as a way of knowing, or the values and beliefs inherent to the development of scientific knowledge" (Abel-Khalick, Bell, & Lederman, 1998, p. 418). Though the data were not specifically analyzed to evaluate teachers' understanding of NOS, the two teachers in this study with extensive research experiences discussed developing an understanding of the social development of science in their interactions with other research scientists. This finding extends previous research that indicated

preservice secondary science teachers who used inquiry-related instructional practices in their student teaching classroom were also the teachers who had authentic undergraduate or career-related research experiences in which they were significant contributors to the overall research project (Windschilt, 2003; Windschitl, 2004).

In order for teachers to rise to the science teaching standards articulated by the NRC's guide for Inquiry and the National Science Education Standards (2000), "teachers need to be well-versed in inquiry and inquiry-based methods" (p. 87). The NRC's claim that many teachers do not have the necessary skills or understandings of scientific inquiry is supported by this study's findings. Most teachers did not have undergraduate science content preparation that actively engaged them in developing these necessary understandings. Recognizing that the majority of teachers' learning experiences as science students at the undergraduate level are passive and lacking in opportunities to be engaged in authentic research, there is a clear need to help teachers develop the skills and knowledge for how to engage in scientific research if teachers are going to be able to implement more reform-based instructional practices which are predicated on having this understanding. Windschitl (2004) argues for the inclusion of more independent inquiry investigations in preservice science methods because if teachers are "to mentor their own students through inquiry, they must feel some intellectual and methodological competence, gained not through reading or hypothetical discussions but through firsthand experience and reflection on that experience" (p. 486).

### **Teachers' Professional Preparation**

Based on the statistical model, this study found the teacher preparation program attended was significantly related to teachers' level of enactment of reform-based instructional practices. Teachers who were graduates from the UI teacher preparation program were much more likely to

implement reform-based practices than teachers from the other two preparation programs. These findings lend support to arguments regarding the positive impact that university-based teacher preparation program can have on teacher quality (Boyd, Grossman, Lankford, Loeb, & Wyckoff, 2009; Brouwer & Korthagen, 2005; Feiman-Nemser, 2001; Tatto, 1998). This study's findings regarding the role of formal teacher preparation in the socialization of teachers to enact educational reforms challenge previous teacher socialization literature which describes preservice teacher preparation programs as "not very powerful interventions" in the socialization of teachers (Zeichner & Gore, 1990, p.338). For two of the six case study teachers, one from SU and one from UI, the effects of their teacher preparation do not appear to be "washed out" by their school experiences (Zeichner & Tabachnick, 1981, p. 9). The significant link found between the teacher preparation program attended and teachers' classroom practice are in line with Brouwer and Korthagen's (2005) research and extends their claim "teacher education can make a difference in regard to the kind of teaching competence that graduates develop" (p. 213) to U.S. secondary science teachers. Though the findings from phase one explicate which program graduates go on to use more reform-based practices, they cannot explain specifically what it is about the components of these programs that leads to this. The additional qualitative findings from phase two help to refine the impact of this variable to further explain the varied experiences teachers had in their teacher preparation programs and how this contributed to the differential implementation of reform-based instructional practices.

As previously described, all three teacher preparation programs shared similarities: they were theoretically aligned, designed with reform-based science pedagogy at the forefront, and had a focus on research-based understandings of teaching and learning to drive the curriculum. However, as Figure 5 detailed, there were several differences in the structural components of the

three programs. Though these structural differences were not explicitly investigated, what emerged from the qualitative data analysis were the dynamic ways in which these six teachers experienced these programs and what stood out as most influential to their developing practice. All six teachers found common ground in their descriptions of the science specific methods courses in their teacher preparation program and valued the kinds of learning experiences inherent in these courses over any of their other teacher education courses. However, one of the main areas in which teachers diverged in their opinions and experiences within their teacher preparation was in relation to their field experiences. The findings indicated that teachers' overall perception of the quality of their teacher preparation was linked to the structure and duration of their field experiences in secondary (7-12) classrooms. The teachers' focused attention on this area of their preparation is consistent with the findings from Wilson, Floden, and Ferrini-Mundy's (2001) meta-analysis of research on the impact of teacher preparation, which indicates teachers report the clinical experiences of their preservice programs to be the most powerful component of their preparation. Boyd et al. (2009) also concluded that teacher preparation program graduates who were more successful in the classroom had experienced more opportunities in their preservice preparation that were "ground in practice." In this study, graduates of the UI teacher preparation program had as much as 200-400 more hours spent in the field as preservice teachers. Though this extra time alone may have been influential, the structure and quality of their field experiences may have strongly contributed to differences in their developing practice as science teachers. Preservice teachers from the UI teacher preparation program spent less of their field experience time in observation roles, and more time in the actual practice of teaching. They also had a series of three field placements that were structured sequentially across the continuum of learning beginning in an elementary classroom,

followed by a middle school experience, and concluding with a full semester of high school student teaching experience. Concurrent with these placements, students returned to university-based science content methods classes to continue to learn about teaching and learning and to continuously refine their research-based rationale for science teaching. The SU program also sought to provide a diversity of field experiences, requiring preservice teachers to have field placements in both suburban and high-needs rural/urban districts across their two formal student teaching placements. NSCU preservice teachers spent the least amount of time in the field in practice and did not have such requirements regarding the nature of their placements. Preservice teachers from the UI program had opportunities to see more examples of teaching from a greater variety of host teachers and had experience working with multiple age groups, which participants described as helping them to have a greater developmental understanding of science learners. They also experienced cycles of practice in the field directly coordinated with science content specific methods courses that the preservice teachers from SU, and to a lesser extent NCSU, experienced in their teacher preparation programs. Graduates from NCSU in particular, expressed that their time in the field was inadequate, did not provide enough concrete experiences for learning practical tasks of running a classroom, and offered too little time to practice effective pedagogy. This finding regarding the structure and duration of field experiences is consistent with previous research in understanding the influences of socialization during teacher preparation on teachers' practice. Brouwer and Korthagen's study (2005) found gradual increases in complexity of student teaching activities as well as alternation of student teaching and college-based periods were effective programmatic features, which influence starting teaching competencies (p. 213). They claimed the "gradual increase in complexity

enabled student teachers to experience success in using theoretical ideas offered by the program while at the same time perceiving the limits of their present competence” (p. 214).

While the structure and duration of field placements played a key role in shaping the different socialization experiences of the teachers in this study, a major component of these experiences were the lessons learned from the preservice teachers’ host/mentor teachers. All the teachers in this study described modeling their practices to some degree after those they observed from the host teachers they received mentoring from during their field experiences. This is consistent with previous research that identified the practices of mentor teachers as “highly influential” and “the single force in an intern’s ecology seemingly most responsible for shaping the practice an intern engages in and believes” (Rozelle, 2010, p. 210) and provides further evidence teachers continue to mimic and model their host teachers’ practice as they move into their own classrooms.

Grossman et al. (2000) in their longitudinal study of literacy teachers claim that “student teaching continues to be a setting that powerfully influences the ways in which teachers appropriate knowledge” (p. 659). In the current study, although all six teachers were overtly positive about their host teachers and valued their experiences during their student teaching placement, the descriptions offered by high practice teachers and low/mean practice teachers differed regarding what knowledge and practices they appropriated from working with their host teachers. The low/mean practice teachers focused their attention on modeling practices related to procedural aspects for planning and maintaining control of the classroom. These four teachers appreciated their host teachers, enjoyed their personalities, and valued their host teachers’ interaction with and control in managing students. They desired to take on these aspects of their teaching as well as other aspects of the host/mentor teachers’ pedagogy that seemed to promote

effective control of the learning environment. These more traditional pedagogical practices developed during this timeframe became dominant in their understandings of effective teaching even though they were not necessarily in line with their initial visions about effective science teaching and were consistent with the reform-based ideas of their teacher preparation program. The high practice teachers descriptions of what they saw modeled and the lessons learned from their host teachers were markedly different, focused on students' needs and learning, the importance of assessment throughout instruction, and the need to provide authentic, relevant experiences for students.

These findings indicate that once teachers entered their own classrooms they still attributed their instructional actions in part to the influence of their student teaching host teacher. However, the current study is limited in understanding the actual instructional practices of the host teachers or the degree to which the practices these host/mentor teachers modeled were adopted by the preservice teachers in the IMPPACT study. The fact the high practice teachers took away different lessons from their mentors appears to be based on having experiences with host teachers who may have modeled reform-based practices, which is often not the norm of preservice science teachers' experiences. Feiman-Nemser (2001) argues "teacher candidates need opportunities to test the theories, use the knowledge, see and try out the practices advocated by the academy" (p. 1024). It appears probable the two high practice teachers had some of these opportunities with host teachers who at best either engaged in and modeled reform-based pedagogy, or at least provided these two preservice teachers the encouragement and space to practice implementing their own visions of good teaching. For most of the teachers in the study this was not the case, and their descriptions of their practice after graduation from teacher preparation were attributed partially to their host teachers' influence. Rozelle (2010) suggests

that even a well structured, reform-based teacher education program may fail to support preservice teachers in learning about the enactment of reform-based teaching, but rather only succeed in teaching students about teaching. He concludes that preservice teachers' primary education in the enactment of teaching comes from their student teaching placements and their host teachers, which in the case of his study, led teachers to take on practices that were not analogous to what the teacher educators had desired. Rozelle contends that at this point in their process of learning to teach, "reform-oriented practices are socialized away" (p. 217).

In all of the discourse regarding their teacher preparation, the findings from this study show the overall take away lessons from teacher preparation, as well as the teachers' overall sense of preparation, distinguished the teachers with lower levels of enactment of reform-based instructional practices from those with higher enactment. Those with lower levels of enactment appreciated most the acquisition of resources and skills for teaching and felt underprepared to teach science effectively, with the exception of Heidi (an SU graduate) who expressed feeling well prepared to teach. The high practice teachers, in addition to valuing skills for teaching, also appreciated developing a research-based understanding of teaching. The three teachers who were graduates of the NCSU teacher preparation program generally felt underprepared for specific tasks of teaching as well as the application of reform-based instructional practices. The deficiencies they felt in being prepared to teach often manifested in the expression of a conflict between the theory and actual practice of reform-based teaching. The two high practice teachers expressed a high sense of being prepared to teach science, felt the theories learned in their preparation regarding teaching and learning of science were integral to their developing practice, and could see how they would be applied in practice. Previous research has demonstrated a high sense of preparedness to teach is linked with a higher sense of efficacy for reform-based



practices (Darling-Hammond, Chung, & Frelow, 2002). The current study extends this research, linking a high sense of preparedness to secondary science teachers' enacted practices.

There are two potential explanations for this juxtaposition of preparedness and lessons learned from teacher preparation between teachers with differing levels of reform-based practice. Teachers who felt unprepared to teach and viewed learning about teaching as the acquisition of skills and resources as a result of their preservice training may have developed these feelings due to the teacher preparation program's lack of opportunities that "foster(ed) learning about and from practice *in practice*" (Darling-Hammond, 2010, p. 42). The desire for more field experiences among preservice teachers is documented by previous research (Adams & Krockover, 1997). Korthagen and Kessels (1999) contend that in order for theory to be helpful to preservice teachers, they need opportunities for "connecting the theory to their actions in the concrete practical situations" (p. 5). This was not the case for Alexander, Amanda, and Mark who appeared to develop a context-dependent understanding of reform-based teaching, lacking the practical or real world situations in which to try to enact these practices, only seeing them as "valid" in what they perceived as the superficial environment of teacher education programs. The development of this tension between the idealized model of reform-based teaching and the realities of the classroom is often expressed by teachers (Anderson & Helms, 2001). As Grossman et al. (2000) conclude, "theory becomes real only through practice" (p. 658). For the teachers in this study, the distinct lack of "practice *in practice*" appeared to relegate theory as applicable only in the confines of the teacher education program.

This brings the discussion back to the exception of Heidi, who expressed feeling very well prepared to teach, and yet like the three NCSU teachers seemed to only acquire skills and resources related to teaching. Another possibility that sheds light on how and why only some

teachers embrace the application of theories of teaching and learning behind the use of reform-based science teaching practices could be related to possessing a deeper understanding of the process of scientific inquiry. The two high practice teachers were the only teachers who had authentic research experiences, were the most interested in how educational theories could improve their teaching, and felt the most prepared to teach science. Though Heidi was also a graduate from SU who felt very well prepared to teach science as a result of her preparation program, her focus on what she took away from the program more closely mirrored the statements made by teachers from NCSU. This could be due to her lack of experiences with scientific inquiry. Perhaps preservice teachers who bring a richness of authentic scientific research experiences to their teacher preparation program are more apt to be receptive to the theoretical underpinnings of reform-based science teaching and are more readily socialized by these programs than teachers without this depth of knowledge about the scientific process. If you consider that the NRC's (2012) assertion in *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* that "students will themselves engage in the practices and not merely learn about them secondhand. Students cannot comprehend scientific practices, nor fully appreciate the nature of scientific knowledge itself, without directly experiencing those practices for themselves" (p.30), then it follows that teachers themselves much possess these same understandings and have experiences with these practices themselves to fully be able to realize this type of pedagogy in the classroom.

### **Local School Context**

This study found socialization factors associated with teachers' local school context were significantly linked to the kinds of instructional practices teachers enact in their classrooms. These findings are consistent with previous research indicating the notable role that school

context has on the socialization of teachers (Achinstein, Ogawa, & Speiglmán, 2004; Brouwer & Korthagen, 2005; Zeichner & Gore, 1990). Brouwer and Korthagen (2005) suggest there are several “socializing influences emanating from the school contexts” that impact teachers (p. 201). The statistical analysis identified two main factors influencing the level of implementation of reform-based instructional practices: 1) perceived levels of professional autonomy; and 2) the quality and content-related nature of teacher professional development. These findings support other large quantitative studies of science teachers’ use of reform-based instructional practices. Smith et al. (2013) found the degree to which teachers’ perceived having pedagogical control was a positive influence on the use of reform-based teaching, supporting the findings of this study related to the relationship between professional autonomy and use of reform-based teaching. Smith et al. (2007) found a strong association between content-related professional development and eighth grade science teachers’ use of reform-based practices. These authors also found teachers without science degrees who participated in sustained content-related professional development reported similar rates of hands-on activities as did teachers with science degrees.

The qualitative analysis further supported the relationship between the level of professional autonomy and teachers’ use of reform-based practices. There were greater feelings of professional autonomy experienced among teachers with high levels of reform-based teaching practices particularly as a result of the influence of both administrators and colleagues. Edgar and Warren (1969) described the process of occupational socialization as a “power process” between the “balance of control and autonomy” (p. 387). This power process over roles and expectations for teachers in the local school context played out very differently for low/mean practice teachers than for the high practice teachers. Low/mean practice teachers were socialized

into schools in which teachers lacked autonomy for curricular and instructional decisions, lacked professional judgment, and felt their professional insight was suppressed by those who had more control in the district (i.e., the administration and more experienced teaching colleagues). These findings are consistent with research that suggests teachers' satisfaction is portrayed as autonomy or the degree to which they felt the "freedom and independence to develop personally satisfying teaching procedures and styles" (Edgar & Warren, 1969, p. 399). In the current study, administrators were seen by participants as playing an inhibiting role and communicated messages of compliance to most teachers. The teachers in this study also felt colleagues set the tone for the culture of teaching, exerting either direct or implicit influence on other teachers' practices. This is similar to previous research finding that departmental culture can serve to undermine reform-oriented efforts (Woodbury & Gess-Newsome 2002). These experiences starkly contrasted the high practice teachers who felt a high degree of decision making authority and flexibility in determining their instructional behaviors. The extent to which teachers perceived having control over their professional role as a teacher impacted what they believed they could accomplish in their developing instructional practice.

This study also found the professional development teachers experienced in their local school context differentiated low and high levels of enactment of reform-based teaching. Those teachers who reported engaging in more quality professional development as well as more science content focused professional development reported greater use of reform-based instructional practices. These findings reflect the NRC (2007) claim that "professional development that supports quality science instruction is ongoing, rooted in the science that teachers teach, and relevant to their classroom contexts" (p. 346). Unlike the other significant variables in this study, the qualitative data with regards to teachers' experiences with district

provided professional development was limited. Most of the case study teachers perceived the structure and content of their respective district's professional development to be insufficient and ineffective. The perceived inadequacies of their professional development are in line with previous research that typifies professional development for teachers and its ability to promote educational reforms. Feiman-Nemser (2001) concludes traditional approaches to professional development "do not fit with the learning requirements of ambitious reforms and standards. They do not help teachers bring new knowledge to bear on practice or generate new knowledge in practice" (p. 1041). This appears to be the situation for a majority of the case study sample, but it is unclear how the teachers who reported quality and content specific professional development experiences in phase one of this study experienced these learning opportunities. Stephen's experience with professional development sheds some light on this. Stephen was the lone teacher in the case study analysis who was overtly positive about his district professional development. Stephen viewed these opportunities as engaging, developed with his needs in mind, and involving work with his peer teachers. Stephen also described working in a school environment structured in such a way that he was engaged in collaborating with teaching colleagues across various disciplines on a daily basis. The NRC (2007) claims that "professional development that supports instructional improvement rests on school- and system-level commitments that are manifest in actively involved leadership and the establishment of regular times throughout the school day for teachers' collaboration" (NRC, 2007, p. 346).

Several themes regarding the socializing influence of the local school context on teachers' practices came out during the qualitative analysis related to non-significant variables in the statistical model and also related to factors not measured by the model. Though the model found the teachers' perception of school culture/climate was not significant, the qualitative analysis

found the culture of support within the teachers' school, their perceived degree of fit within the district, as well as their thoughts concerning students' impact on their practices differentiated low/mean practice teachers from high practice teachers.

Most teachers expressed being a part of a supportive school culture; however the nature of this supportive culture appears to have implications for teachers' instructional practices. All six teachers expressed receiving adequate support for procedural or practical aspects of teaching. However, the high practice teachers' culture of support extended beyond this to include support focused on instructional decisions. This finding is consistent with what research has shown about support provided to new teachers during their induction. Feiman-Nemser (2001) characterizes the typical support for new teachers as "focused on advice, hand-holding, materials, seek to reduce stress and address immediate problems rather than promoting teacher development and improving the quality of teaching and learning" (p. 1031). The difference in the degree of support felt by these teachers can be viewed through what Feiman-Nemser described as two very different kinds of supportive colleagues: the "local guides" versus "educational companions." Local guides are colleagues or mentors who offer this kind of procedural support experienced by all six teachers in this study, helping new teachers learn the school-wide procedures, answering questions, providing emotional support, and giving advice in the short term until teachers become more confident. Offering a contrasting level of support, educational companions view their role differently, "helping novices focus on student thinking and on developing sound reasons for their actions" (p. 1032). The high practice teachers describe being socialized into school contexts in which they received support from educational companions, which helped them to continue to focus on their pedagogy in ways to support student learning. These findings support previous research claiming more collegial support and collaboration can

significantly influence teachers' beliefs and practices (Anderson & Helms, 2001); the findings also extend this understanding that the type of support provided to new teachers matters for influencing secondary science teachers' use of reform-based practices. Additional research suggests that a culture of support is influential to teachers practice and for reforming science instruction when teachers have regular collaboration with these educational companions in their day-to-day work (Anderson & Helms, 2001). This kind of regular collaboration for "substantive talk with like minded colleagues help teachers overcome their isolation and build communities of practice" (Feiman-Nemser, 2001, p. 1043). Stephen, the case study teacher with the highest enactment of reform-based instructional practices, described being a part of such a community of practice due to the organization of his school into learning academies and sharing an interdisciplinary office space that involved focused discussion on a daily basis regarding best practices to support student learning.

The findings regarding the culture of support experienced by teachers appears to be interrelated with the degree of fit between teachers and their school district shaped by the administrators' philosophy of education and support for teachers. This perception of degree of fit speaks to a broader school/district culture that aligns more with teachers' own ideas about effective teaching and learning. The low/mean practice teachers expressed different sentiments regarding this degree of fit compared to the high practice teachers. They perceived a lack of fit between their own beliefs about good teaching and the ideals learned about reform-based practices from their teacher preparation program with those promoted by the administration of their school district. As a result, these teachers described feeling frustrated with administration, feeling unsupported in many aspects of their teaching, and generally feeling less autonomous in their role as a teacher. These outcomes are consistent with previous research with respect to new

teachers' frustration with district organization factors, such as principal and administrative practices (Edgar & Warren, 1969), and the relationship between district professional culture and teachers' best practices (Achinstein, Ogawa, & Speiglmán, 2004). Edgar and Warren (1969) conclude the "nature of affective relationships between the new teacher and his evaluators is a vital motivational condition in the socialization process" (p. 388). Beyond feeling aligned philosophically, the high practice teachers in this study frequently discussed a positive relationship with their administrators feeling supported, respected, and valued for their professional work. These different socialization experiences between the high and low/mean practice teachers with regards to the culture of support and degree of fit within the local school contexts can be viewed through what Brouwer and Korthagen (2005) described as "discrepancy experiences." Their study built on the work of Dann et al., 1978 (as cited in Brouwer & Korthagen, 2005), which identified discrepancy experiences as critical socialization experiences of new teachers when they experience an inconsistency between the idealistic beliefs developed during their teacher preparation program and the pressures in their local school context to use more traditional practices (p. 155). The findings from this study are consistent with Brouwer and Korthagen's findings that the more discrepancy experiences with respect to colleagues and administrators a teacher contends with as they begin their teaching career, the less likely they are to implement reform-based teaching practices.

This study also found that having discrepancy experiences in relation to the students differentiated the low/mean practice teachers from the high practice teachers. The low/mean practice teachers used a deficit oriented discourse in relation to which students could handle and benefit from reform-based instructional practices. Consistent with previous research, reform-based instructional practices are most often viewed as most appropriate for higher performing



students (Anderson & Helms, 2001; Desimone, Smith, Baker, & Ueno, 2005). The teachers in this study indicated reform-based teaching was more suitable for their honors students or students of high academic ability and claimed the abilities of their lower performing students' prevented them from being able to implement practices more aligned with their teacher preparation. Beyond students' learning abilities, several of the teacher participants also viewed students' demographics or backgrounds as significant with regard to the type of instructional practices they employed. In this current study, student behavior was linked to the type of instructional strategies used. Teachers claimed their students could not handle a more student-centered approach due to their poor behavior. These teachers who were frustrated with their ability to manage the classroom effectively often saw pedagogy as a tool of management, favoring more traditional teacher-centered practices where the teacher retains most of the control. They were unable to envision how reform-based practices could function as an invitation to learn, using these instructional strategies as ways to motivate and keep students engaged and interested. Both explicitly and implicitly, low/mean practice teachers perceived that their students were resistant to reform-based teaching and described students in deficit oriented language, claiming they were lacking initiative or motivation necessary for these instructional practices to be successful. This type of deficit oriented language regarding "this kind of student" or "my kids" was most frequently heard from teachers working in urban school districts who did not share the racial or socioeconomic backgrounds of their students. The data analysis revealed that the greater the discrepancy between teachers' previous teaching experiences and their current urban district teaching context, the more teachers perceived "their students" to be unsuccessful in classrooms utilizing reform-based practices. Instead, these teachers expressed that their students needed more direct instruction and individual work. This is consistent with

previous research indicating inquiry science teaching varies along socioeconomic lines with the higher proportion of low-income and minority students receiving more teacher-directed and less inquiry-based instruction (Thadani, Cook, Griffis, Wise & Blakey, 2010) and that, in general, teaching that is socially just “occurs all too rarely and is especially uncommon in urban and other schools with large numbers of students who are poor, minority, immigrant, or have special learning needs” (Cochran-Smith et al., 2009, p. 374).

There are several potential explanations for why teachers such as the low/mean practices teachers in the current study develop these deficit oriented pedagogical viewpoints as a result of their teacher socialization. As teachers are inducted into an urban school context, they are socialized into a “pedagogy of poverty,” described by Haberman (1991) as a typical form of teaching prevalent in urban schools. This pervasive approach to teaching negates the principles of reform-based teaching. Haberman defines the pedagogy of poverty as a systematic approach to urban education in which all key individuals work in concert to promote a learning environment characterized by authoritative, controlling instruction, which generally holds low expectations for learners, favoring students to be passively engaged in learning. Haberman claims that a pedagogy of poverty “is sufficiently powerful to undermine the implementation of any reform effort” (p. 292). As teachers are socialized into these environments, they are often seen as successful only if they become willing participants in this system of pedagogy, which is partially why Haberman describes the unit of change is not the individual teacher, but the whole school community. This type of pedagogy serves to reinforce the inequities of the education system, relegating low income and minority students to less challenging learning opportunities usually afforded to more privileged students (Cochran-Smith et al., 2009). This view of the type of instruction that best supports science learners in urban districts is pervasive even in spite of

evidence that challenges the pedagogy of poverty. Research has shown when students in urban schools are engaged by more inquiry-based instructional approaches they experienced greater gains on content learning assessments (Geier et al., 2008; Thadani, Cook, Griffis, Wise & Blakey, 2010).

Though the research base provides clear evidence of the detrimental effect a pedagogy of poverty has on the socialization of teachers in urban districts, teachers' viewings regarding their students could also be a problem resulting from their preservice teacher preparation. The teachers in this study who held deficit oriented views of their students did not necessarily receive explicit preparation in teaching students from diverse backgrounds, despite the fact that teachers are increasingly teaching "students whose racial, cultural, and socioeconomic backgrounds differ markedly from their own" (Feiman-Nemser, 2001, p. 1018). Feiman-Nemser argues that one of the central tasks of learning to teach is to "cultivate the tools and dispositions to learn about students, their families, and communities and to build on this knowledge in teaching and learning" (p. 1018). In previous research, Feiman-Nemser et al. (1999) found that district coordinators of urban induction programs reported regularly having to make up for new teachers' deficiencies in working with culturally diverse students (p. 24). Three of the four teachers in this study, who held limited views regarding the efficacy of reform-based instructional practices for particular students, worked in urban districts and lacked prior field experiences or teacher education experiences geared toward preparing them for this type of school context. Though there is no certain way to link these views to explain their eventual thoughts on pedagogical enactment for their specific student population, it is entirely plausible that teachers who had more diverse field placements during their preservice program felt better prepared for this school context.

## **Policy Environment**

Though the quantitative analysis did not find the policy related variable significant to the overall explanation of enactment of reform-based instructional practices, additional qualitative analysis supported previous research findings indicating “the local school and district contexts exert a profound influence on teacher socialization both directly and by mediating the impact of state instructional and accountability policies” (Achinstein, Ogawa, Speiglmán 2004, p. 589). The results of the qualitative analysis identified how low/mean practice teachers and high practice teachers experienced unique socialization pressures as a result of the influence of state policies.

Previous research asserts what teachers believe and how they act is influenced by policy mandates (Lasky, 2005). The two groups of teachers involved in the current study perceived the influence of the state curriculum in very different ways. Low/mean practice teachers portrayed a sense of being consumed by the state curriculum, feeling it drove the entirety of what they taught and how much time they devoted to various concepts, even to the detriment of assuring student understanding. Consistent with previous research, the four teachers in this study felt they did not have enough time to cover all the content as written in the state curriculum documents (Adams & Krockover, 1997; Anderson & Helms, 2001). These low/mean practice teachers expressed frustration over their inability to determine the content and pace of their classroom instruction. The high practice teachers operated within similar state curriculum constraints but expressed being responsive to the challenges of state policies, believing they maintained control for making instructional decisions and feeling that the state curriculum informed what they taught rather than drove all instructional choices.

This difference in perception appears to be related to the teachers' sense of agency for their professional role as a science teacher. The frustration expressed by the low/mean practice teachers was in their lack of influence or control over professional decision making related to curriculum. This is similar to Lasky's (2005) findings, which indicated that in response to curricular reforms and new accountability systems, teachers' perceptions were that "their professionalism was being systematically eroded by the current reform context" (p. 913). Day (2002) further argues that policy agendas related to accountability serve to further decrease teacher effectiveness by threatening a teacher's sense of agency. In trying to discern why there might be a difference in sense of agency among the high practice teachers and the low/mean practice teachers, it would be useful to understand the development of these teachers' sense of agency. Priestley, Edwards, Priestley & Miller (2012) view teacher agency in an "ecological way, strongly connected to the contextual conditions within which it is achieved and not as merely a capacity or possession of the individual" (p. 13). These authors posit that change in agency can be positive or negative in response to teachers' evolving experiences and social conditions (p. 13). As the previous findings have demonstrated, the high practice teachers had very different experiences in preservice programs during their student teaching field placements and were socialized into school cultures dominated by a high degree of autonomy for creative professional judgment coupled with a supportive culture that valued the teacher as a professional. Sloan (2006) found that the degree to which the teachers in his study were able to exhibit agency was related to how they "identify themselves with or to the figured world of school and the amount and quality of their knowledge, both professional and personal, of curriculum and pedagogy" (p. 142). Thus, it is possible the interaction between what the high practice teachers learned from their preservice preparation and early teaching experiences, and how this then was

interpreted in the context of their school environment, had a higher degree of fit with their philosophies of reform-based science teaching. These experiences likely have led these teachers to develop a more robust sense of agency than the ecological conditions experienced by the low/mean practice teachers did not foster.

In addition to the influence of the state curriculum, low/mean practice teachers acknowledged that their districts' response to state accountability measures and the end of course content exams exerted pressure on their instruction. Many of these teachers felt the districts communicated a priority on raising students' scores above all else, which in turn constrained their instruction. These findings are consistent with previous research claiming science teachers' use of reform-based instructional practices are constrained by these standardized testing pressures (McGinnis, Parker, & Graeber, 2004). In the current study, teachers noted they felt pressure to alter their instructional practices in response to the administrators' focus on test scores. Their instruction reflected the nature of the state assessments and included time spent on specific test taking strategies, even in light of feeling there was an insufficient amount of time to effectively cover all the content. This is consistent with Abrams, Pedulla & Madaus' (2003) findings from a national survey that when under pressure to raise students' test scores, teachers spent a considerable part of their instructional time devoted to test preparation. These authors also contend the impact of state testing policies is pervasive, finding that a majority of teachers in both high stakes and low stakes testing states indicated they "teach in ways that contradict their own notions of sound educational practice" (p.23). These findings are also consistent with research which reflects how accountability pressures that encourage a mentality of "teach-to-the-test" can explicitly influence teacher practice (Southerland, Abrams, & Hunter, 2008) and "implicitly encourage teachers to comply uncritically" (Day, 2002, p. 605).

## Conclusions

Consistent with national trends in practice, few teachers in this study realized the kinds of instructional practices advocated for in science education reform documents, with more traditional practices most prevalent in their science classrooms. The results of this study help to explain the variation in enactment of reform-based instructional practices of graduates from three reform-oriented teacher preparation programs; to explicate what differentiates those teachers who go on to implement the practices learned during their teacher preparation programs from those who do not. The findings from this sequential explanatory mixed-methods study support previous research regarding how various contexts interact to shape the socialization of teachers (Brouwer & Korthagen, 2005; Achinstein, Ogawa & Speiglmán, 2004) and adds substantially to the research base by tracing the trajectory of the socialization experiences for secondary science teachers and the resulting impact on their enacted classroom practices, specifically with regard to their use of reform-based instructional practices. The quantitative analysis provides a broad understanding of the significance of the role that both teacher preparation experiences and the local context play in shaping the kinds of instructional practices science teachers enact. The secondary case study analysis provides deeper insight to better understand the nuances of the socialization experiences for these six teachers across the multiple contexts as a part of their overall teacher development.

This combination of statistical analysis and case studies helps to explain and differentiate those teachers with high levels of enactment of reform-based instructional practices from those who utilize more traditional teaching methods. From these data analyses, what set the teachers who enacted reform-based instructional practices apart from those who did not were the following critical factors: a) having extensive science research experiences prior to their

professional preparation; b) the teacher preparation program attended, specifically components related to the structure and quality of their field experiences; c) developing and valuing a research-based understanding of teaching and learning as a result of their preservice teacher preparation experiences; d) the professional culture of their school context where there was support for a high degree of professional autonomy, providing quality science-content specific professional development, and receiving support from “educational companions” with a specific focus on teacher pedagogy to support student learning; and e) possessing a greater sense of agency to navigate their districts’ interpretation and implementation of state policies.

These findings document the contribution of various aspects of teacher’s socialization to the eventual practices they enact in the classroom, particularly the significant role of teacher preparation and the local school context. Though the findings indicated a clear difference between the practices of teachers from different teacher preparation programs, there were also differences within teacher preparation programs. The preservice program completed by the participants in this study was significant regarding teachers’ use of reform-based practices, but the mechanism of program influence appeared to be explained by the structure and quality of field experiences, including the influence of the host teacher. Goodlad (1990) noted most often teachers have experiences in teacher preparation that are of an “operational rather than intellectual socialization into teaching” (p. 225). The teachers in this study with the most reformed practices emerged from their experiences in both their practice in the field and their content methods courses with an intellectual orientation toward teaching, developing a deeper, research-based understanding of science teaching and learning. Examining these teachers’ earlier socialization experiences prior to teacher preparation may provide insight to understand the within program differences and why only two teachers developed an intellectual orientation,



fully engaging with the research-based understandings promoted within their teacher preparation program. Though all the case study teachers experienced similar college science content preparation, only the two high practice teachers had extensive research experience prior to entering their teacher education program. These experiences helped socialize these individuals concerning the nature of scientific inquiry, fostering an understanding of the processes and content of science. It is these two teachers who then went on to develop the richest research-based understanding of reform-based teaching. Feiman-Nemser (2001) argues the ideas and beliefs preservice teachers “bring to their teacher preparation influence what they are able to learn” (p. 1016). The degree of practical understanding of the nature of scientific inquiry preservice teachers bring to their teacher preparation may be important for their ability to develop an understanding and perceive the applicability of reform-based science teaching to their pedagogy in theory and in practice.

The understanding of teaching the participants in this study took away from their preparation programs were further influenced by the school contexts into which they were inducted. Many of the teachers who did not implement reform-based practices entered into school environments as beginning teachers that did not encourage the professionalization of teachers; rather, it pressured them into conforming to the standards set by administrators and more experienced colleagues. For many teachers, the process of transitioning from student to teacher is “more of an occupational than an intellectual transcendence” (Goodlad, 1990, p. 214). As with teacher preparation, the nature of the school context in which teachers continue to be socialized can “reinforce an operational rather than an intellectual orientation toward teaching, a concern for how to do it rather than why teach in a given way” (Feiman-Nemser, et al., 1999, p. 17). This reinforcement of particular orientations towards teaching by the school context rings

true for the teachers in this study. The teachers who graduated with a more intellectual orientation toward reform-based science teaching also happened to be socialized into a school context which fostered a culture of support that focused on this intellectual approach; they were guided by administrators who valued this approach and experienced autonomy to enact this orientation to teaching. Due in part to the district philosophy regarding education and their sense of agency, these teachers were able to continue their practices even when discussing constraints of state policies.

These findings suggest that across the different spheres of socialization, there are key components and experiences within the teacher socialization process that are layered upon one another as teachers progress through their teacher development, either further supporting an intellectual orientation toward a pedagogical enactment of reform-based science teaching or socializing teachers into accepting the status quo of traditional educational practices. In this study, teachers enacting high levels of reform-based practices had more complementary socialization experiences, which helped them to envision the intersection between the theory and practice of reform-based pedagogy. This was different from the rest of the teachers who experienced various competing experiences during their socialization into teaching. It appears the interaction of these layers of socialization- that is, the degree to which teachers experience competing or complementary socialization experiences as novice teachers, determine which practices they eventually adopt. If we view the development of teacher agency in an “ecological way” as Priestley, Edwards, Priestley & Miller (2012) suggest, all of these layers of socialization context and experiences contribute to the sense of agency for implementing reform-based instructional practices. The teachers who implemented reform-based instruction practices developed a sense of agency for doing so due in part to their complementary socialization

experiences which worked to reinforce this sense of agency. The ecological conditions and competing influences the other teachers in this study experienced failed to help them develop a similar sense of agency necessary to overcome the divide they experienced between theory and the reality of enacting reform-based teaching.

### **Implications**

The findings from this study dispute the positioning of either teacher preparation or school contexts as having a single driving influence on the kinds of practices teachers enact in the classroom. The NRC (2012) stressed “in order to support implementation of the new standards and the curricula designed to achieve them, the initial preparation and professional development of teachers of science will need to change” (p. 255). The research findings in this study clearly demonstrate both teacher preparation and professional development play a major role in reform-based instructional practices making their way into the secondary science classroom. As such, these findings have implications for key stakeholders in both settings.

Teacher educators need to identify what understandings and knowledge their preservice teachers possess regarding the nature of scientific inquiry learned through prior research experiences and consider how to best support teachers who come to preservice preparation lacking socialization experiences regarding the nature of scientific inquiry. This could mean incorporating research experiences into the science content methods courses, collaborating with scientists on campus to offer independent research experiences for preservice science teachers, or requiring internships in a research setting. The key to these experiences is that they offer some degree of authentic involvement in the research rather than just supportive low-level assistance that fails to emphasize the practices of science outlined in the NGSS (NRC, 2013).

These findings, as well as previous research, point to the critical role that field experiences play in teachers' developing pedagogy. Grossman et al. (2000) make the assertion that "providing teachers with pedagogical tools for teaching is important but not sufficient. Teacher educators must provide opportunities for preservice teachers to experience these tools in practice. Teachers' more refined understandings of the tools emerged through the activity of teaching and learning" (p. 658). However, the kinds of opportunities for this type of practice vary widely. In the current study, it was clear that it was not only the quantity of hours spent in the field, but the structure and activities associated with these placements that mattered most. Feiman-Nemser (2001) speaks to the importance of "purposeful design and use of field experiences" (p. 1024). A look to the UI program as it was structured at the time of this study reveals a developmental sequence of placements across elementary, middle, and high school levels, each involving the preservice teacher in an active role beyond simply observing the host teacher's instructional practices. The time spent in these placements was alternated with time spent in three content-specific science methods classes in which the teachers developed a research-based rationale for teaching that was revised in each successive semester. Korthagen and Kessels (1999) described this kind of "alternation and integration of theory and practice" (p.5) as a vehicle for promoting transfer from teacher education to practice.

Teacher educators also need to consider how to best prepare preservice teachers for aspects of the school context likely to influence their instructional practices as novice teachers. This includes how to teach in contexts with diverse populations of student backgrounds and abilities, holding high standards of instruction and achievement for all students. Cochran-Smith et al. (2009) posits that teacher education should have a social justice component with "deliberate intention during the preservice period of providing the social, intellectual, and

organizational contexts that prepare teachers to teach for social justice in K–12 educational settings and also support them as they try to live out this commitment as educators” (p. 350).

There are also implications for those involved in the continuing development of teachers in the school context. These findings suggest school administrators and other key teacher mentors need to pay attention to the socialization of teachers during their early induction in terms of support, learning the landscape of the local context, and increasing time spent in communities of practice focused on teaching effectiveness. Teacher induction programs are “conceived as a “bridge” from student of teaching to teacher of student”; however teacher induction has not always offered the kind of support, guidance, and orientation programs that are characteristic of other professions (Ingersoll & Strong, 2011, p.203). Feiman-Nemser, et al. (1999) argue policies that shape the nature of teacher induction programs are influenced by how the transition from preservice to in-service is perceived. These scholars contend:

“If we think of induction as a process of professional socialization, we are more likely to see the need for shared standards, school-university partnerships and graduated responsibilities for new teachers. If we think of induction as a process of “learning the ropes” and fitting in, we are more likely to think in terms of an orientation to the school and district and short-term support to help new teachers manage their first year on the job” (Feiman-Nemser et al., 1999, p. 15)

Policy makers and district administrators need to conceive of teacher induction as a process of professional socialization, creating opportunities for teachers to experience induction with mentors who go beyond being local guides and incorporate teachers into a community of practice.

### **Limitations**

Though this study has several strengths in design and analysis, there are key limitations that should be noted. Perhaps the most significant limitation is the nature of this study using extant data for purposes of secondary analysis. Using the IMPPACT data did make it possible to conduct the current study, as the time and resources need to collect the requisite data for a sequential explanatory mixed-methods study would have been beyond the reach of my dissertation; however, it did pose some challenges. Though the existing study was rich in data, there were inevitably areas in which data was either weak or non-existent to fully develop the model and qualitative analysis as desired for this specific investigation. As a result, the regression model may lack important variables for which there was no quantitative measure.

Due to this choice of data, there was a lack of control over the nature of the survey data obtained. Though all the survey instruments used in the study were chosen based on previous research deeming them valid and reliable measures for their intended purposes, several of the questions on the instruments may not have been the best proxies for the variables of interest for my particular study. This could have limited the construct validity of the variables in the model. In some cases, with more control over survey design and wording, variables may have been better operationalized to suit the needs of the current research study. It is possible that variables of interest that were found to be insignificant in the model but prevalent in the qualitative analysis could be due to some of the scales being misleading to teachers completing the survey or not appropriately measuring the intended construct, such as the policy scale and school culture scale. The overall sample size for the model was limited to the number of teachers in the IMPPACT study who completed the surveys. Though the sample size for this study allowed for adequate power for this particular study, it also limited the number of predictors that could be

entered. Additional predictors would have lowered the power for this study further had they been available.

As with the quantitative data, the qualitative development of teacher cases was limited by what de-identified data were available to me for secondary analysis. The IMPPACT study collected numerous in-depth interviews with each of its sub-sample participants that allowed for a wealth of qualitative data related to the questions of interest for my study. However, the inability to ask for clarification or follow up on answers given during the interviews conducted during the time of the IMPPACT study was somewhat limiting to the analysis.

### **Recommendations for Future Research**

The findings from this research study deepen our understanding of secondary science teachers' use of reform-based instructional practices as a result of their socialization experiences in their preservice program and as beginning teachers. The results are valuable as they contribute both to a broad, generalizable understanding of the role of teacher preparation and the local school context, as well as provide valuable insights into how teachers experienced the various spheres of teacher socialization. However, this study raises more questions about the process of teacher socialization and the development of teachers' enacted instructional practices.

The two teachers in the qualitative study who implemented reform-based instructional practices communicated a sense of agency for their knowledge and enactment of reform-based teaching. However more research is needed to dig further into the role that teachers' sense of agency plays in the socialization process of secondary science teachers. Though I assert that having complementary socialization experiences could help to foster this sense of agency, it would be plausible to question if this could also be a quality inherent in these two teachers, prior

to entering their teacher preparation program. Future research could try to determine what kind of agency incoming preservice teachers have regarding science teaching to better understand how teacher preparation- and later, school context continue to redefine and shape this sense of agency. Future research could also include more facets of teachers' personal backgrounds, such as measures of their competencies (GPA, transcript reviews, scores on entrance exams or state licensing exams) and a measure of teachers' prior research experiences to differentiate those who take on an intellectual orientation to teaching and find success in connecting the theory and practices espoused in their reform-based teacher preparation programs with those teachers who graduate with a more operational view of teaching. Another variable of interest missing from the model is a quantitative measure of the influence of the student population on teacher practice. Due to the qualitative findings from the study regarding the relationship of teachers' views of students with instructional practices, future research would benefit by collecting more data regarding the students in the local school context.

Other questions remain regarding the specific influence of teacher preparation components on teachers' eventual practices. What combinations of teacher preparation components and field experiences work to help teachers develop a sense of agency as a reform-based science teacher? A more in-depth qualitative analysis using a larger sample of teachers within the same teacher preparation, as well as comparisons among teacher preparation programs with specific attention to teacher agency, could help to answer this important question. Taking a more phenomenological approach to this investigation would also add richness to the experiences teachers describe regarding their teacher preparation components. Another fruitful area for future research is exploring the actual role the field placement host teachers play in the socialization of preservice teachers. This study primarily relied on the participating teachers'



views about their host teachers. Future research that seeks to make the connection between the socialization of teachers during their student teaching and the degree to which their host teachers' practices become assimilated into their own pedagogy once they graduated and move into their own classroom requires detailed data regarding the interactions between host teacher and student teacher, as well as field placement observational data and interviews with the host teachers about their own pedagogical beliefs and practices.

These findings also raise more questions about where and how teachers end up teaching in the schools that they do. How do teachers select or attain their positions in their school districts: 1) do teachers self-select into districts so that better prepared/more confident teachers select into districts that allow them the autonomy or degree of fit needed to be successful in using these practices and enacting their visions of good teaching; or 2) are they selected into these districts based on being perceived as better prepared on some other unmeasured component? Is it a function of teacher tracking, in which the most reform-based teachers end up in districts with more overall capital to recruit these teachers, thus perpetuating a system of reinforcing inequities in education, as Achinstein, Ogawa, & Spiegelman (2004) found in their study of teacher socialization? Future research should explore the mechanisms of job searching/hiring processes of secondary science teachers in relation to their enacted practices to answer these questions.

In relation to this point, in this study the high practice teachers had complementary socialization influences on their practice which helped to shape their use of reform-based instruction. Upon graduation they entered school districts that valued them as professionals and provided a high degree of fit for their professional desires. However, it is unclear if other teacher preparation graduates with understandings and practices comparable to the two high practice

teachers who may have entered into a school context that offered competing socialization influences, if their preparation experiences would “counterbalance the occupational socialization” (Brouwer & Korthagen, 2005). The question remains: what happens when this “type” of teacher preparation graduate is socialized into a district that does not provide a degree of fit? It would therefore be prudent for future research to extend the current investigation to include more case studies of teachers who leave their teacher preparation program as well prepared as these two high practice teachers and follow their socialization during their induction period to learn more about what specifically influences their instructional practices in school environments that are both supportive of, and contrary to, reform-based science instruction.

Beyond these lingering questions, there are also other areas in which this research could be pursued in the future. The use of teachers’ self-report data of their teaching practices had been found to be a valid and reliable measure of how often teaching practices align with standards in reform documents and particularly when using composite variables to measure certain aspects of teaching and can differentiate those who do and do not use reform-based practices (Mayer, 1999). However, this type of self report data regarding instructional practices may not be as useful in distinguishing the quality of implementation of reform-based teaching. Future studies using observational measures of teachers’ instructional practices would be beneficial to add validity to the findings regarding the extent and quality of enacted reform-based practices. There are several observational rubrics of science teacher practice that could be employed to facilitate this measure for analysis. This does, however, involve more resources, time, and additional researchers to ensure validity of the observational data. Another way in which to analyze the current self-reported survey data would be to look at specific sub-sections of practice to understand if certain types of instructional practices are differentially influenced by

the socialization factors identified in this study. In looking at sub-sections of teacher practice, it would also be useful to include a measure of teachers' assessment practices as well to gain a deeper understanding of variation in assessment strategies employed to judge science learning on the part of students.

Finally, though the regression model used in this study is an appropriate quantitative analysis for the data used to answer the key research questions, there are other types of analyses that future research might consider to better refine the understanding of the relationships between important variables. The use of path analysis or structural equation modeling could aid in this endeavor to help determine the indirect effects of mediating variables as well as the direct effects to more fully understand how each of these variables influences practice. These analysis techniques may also lead to a better informal theory of the cause and effect relationship between the predictor variables and teacher practice (Keith, 2006). Future research could also utilize Q-sort analysis to further distinguish low, mean, and high level groups of reform-based practice teachers. The use of Q methodology can aid researchers in obtaining a measure of subjectivity, investigating the feelings and opinions of various individuals within in a group (Newman & Ramlo, 2010). Given that individuals can be sorted and grouped based on their perspectives, this could be a useful tool to further refine how constructs such as autonomy, school culture and climate, degree of fit, policy pressures, and sense of agency differentiate teachers' practices.

## Appendix A BARSTL Survey

### IMPACT Project

#### The BARSTL Questionnaire

#### How to Answer Each Question

On the next few pages, you will find 32 sentences. For each sentence, circle only one number corresponding to your answer.

		Strongly Disagree	Disagree	Agree	Strongly Agree
14	During a lesson, students need to be given opportunities to test, debate, and challenge ideas with their peers.	1	2	3	4

- If you *strongly agree* that students should be given these opportunities during a lesson, circle the 4.
- If you *strongly disagree* that students should be given these opportunities during a lesson, circle the 1.
- Or you can choose the number 2 or 3 if one of these better reflects your beliefs.

#### 3. How to Change Your Answer

If you want to change your answer, cross it out and circle a new number, For example:

14	During a lesson, students need to be given opportunities to test, debate, and challenge ideas with their peers.	1	2	3	4
----	---	---	---	---	---

#### 4. Completing the Questionnaire

Now turn the page and please give an answer for every question.

### How People Learn About Science

The statements below describe different viewpoints concerning the ways students learn about science. Based on your beliefs about how people learn, indicate if you agree or disagree with each of the statements below using the following scale: Strongly disagree = 1,

Disagree = 2, Agree = 3, and Strongly agree = 4.

		Strongly Disagree	Disagree	Agree	Strongly Agree
1	Students develop many beliefs about how the world works before they ever study about science in school.	1	2	3	4
2	Students learn in a disorderly fashion; they create their own knowledge by modifying their existing ideas in an effort to make sense of new and past experiences.	1	2	3	4
3	People are either talented at science or they are not, therefore student achievement in science is a reflection of their natural abilities.	1	2	3	4
4	Students are more likely to understand a scientific concept if the teacher explains the concept in a way that is clear and easy to understand.	1	2	3	4
5	Frequently, students have difficulty learning scientific concepts in school because their beliefs about how the world works are often resistant to change.	1	2	3	4
6	Learning science is an orderly process; students learn by gradually accumulating more information about a topic over time.	1	2	3	4
7	Students know very little about science before they learn it in school.	1	2	3	4
8	Students learn the most when they are able to test, discuss, and debate many possible answers during activities that involve social interaction.	1	2	3	4

### Lesson Design and Implementation

The statements below describe different ways science lessons can be designed and taught in school. Based on your opinion of how science should be taught, indicate if you agree or disagree with each of the statements below using the following scale: Strongly disagree = 1, Disagree = 2, Agree = 3, and Strongly agree = 4.

		Strongly Disagree	Disagree	Agree	Strongly Agree
9	During a lesson, students should explore and conduct their own experiments with hands-on-materials before the teacher discusses any scientific concepts with them.	1	2	3	4
10	During a lesson, teachers should spend more time asking questions that trigger divergent ways of thinking than	1	2	3	4

	explaining the concept to students.				
11	Whenever students conduct an experiment during a science lesson, the teacher should give step-by-step instructions for the students to follow in order to prevent confusion and to make sure students get the correct results.	1	2	3	4
12	Experiments should be included in lessons as a way to reinforce the scientific concepts students have already learned in class.	1	2	3	4
13	Lessons should be designed in a way that allows students to learn new concepts through inquiry instead of through a lecture, a reading, or a demonstration.	1	2	3	4
14	During a lesson, students need to be given opportunities to test, debate, and challenge ideas with their peers.	1	2	3	4
15	During a lesson, all of the students in the class should be encouraged to use the same approach for conducting an experiment or solving a problem.	1	2	3	4
16	Assessments in science classes should only be given after instruction is completed; that way the teacher can determine if the students have learned the material covered in class.	1	2	3	4

### Characteristics of Teachers and the Learning Environment

The statements below describe different characteristics of teachers and classroom learning environments. Based on your opinion of what a good science teacher is like and what a classroom should be like, indicate if you agree or disagree with each of the statements below using the following scale: Strongly disagree = 1, Disagree = 2, Agree = 3, and Strongly agree = 4.

		Strongly Disagree	Disagree	Agree	Strongly Agree
17	Students should do most of the talking in science classrooms	1	2	3	4
18	Students should work independently as much as possible so they do not learn to rely on other students to do their work for them.	1	2	3	4
19	In science classrooms, students should be encouraged to challenge ideas while maintaining a climate of respect for what others have to say.	1	2	3	4
20	Teachers should allow students to help determine the direction and the focus of a lesson.	1	2	3	4
21	Students should be willing to accept the scientific ideas and theories presented to them during science class without question.	1	2	3	4
22	An excellent science teacher is someone who is really good at explaining complicated concepts clearly and simply so that everyone understands.	1	2	3	4
23	The teacher should motivate students to finish their work as	1	2	3	4

	quickly as possible.				
24	Science teachers should primarily act as a resource person; working to support and enhance student investigations rather than explaining how things work.	1	2	3	4

### The Nature of the Science Curriculum

The following statements describe different things that students can learn about in science while in school. Based on your opinion of what students should learn during their science classes, indicate if you agree or disagree with each of the statements below using the following scale: Strongly disagree = 1, Disagree = 2, Agree = 3, and Strongly agree = 4.

		Strongly Disagree	Disagree	Agree	Strongly Agree
25	A good science curriculum should focus on only a few scientific concepts a year, but in great detail.	1	2	3	4
26	The science curriculum should focus on the basic facts and skills of science that students will need to know later.	1	2	3	4
27	Students should know that scientific knowledge is discovered using the scientific method.	1	2	3	4
28	The science curriculum should encourage students to learn and value alternative modes of investigation or problem solving.	1	2	3	4
29	In order to prepare students for future classes, college, or a career in science, the science curriculum should cover as many different topics as possible over the course of a school year.	1	2	3	4
30	The science curriculum should help students develop the reasoning skills and habits of mind necessary to do science.	1	2	3	4
31	Students should learn that all science is based on a single scientific method—a step-by-step procedure that begins with ‘define the problem’ and ends with ‘reporting the results.’	1	2	3	4
32	A good science curriculum should focus on the history and nature of science and how science affects people and societies.	1	2	3	4

**Appendix B**  
**SEC Survey**



**IMPACT Project**  
**Survey of Instructional Practices**  
**Science**

*Thank you for agreeing to participate in this survey of instructional practice. Your personal information will remain strictly confidential. Information that could be used to identify you or used to connect you to individual results will not be shared with staff in your school, district, or state.*

*Selecting the Target Class—For all questions about instructional practices please refer only to activities in the Science class that you teach. If you teach more than one Science class, select the first class that you teach each week.*

*Please turn the page and begin the survey.*



The following pages request information regarding students in the target Science class for the current school year.

Please read each question and the possible responses carefully, and then mark your response by filling in the appropriate circle in the response section. A pen or pencil may be used to complete the survey.

### SCHOOL DESCRIPTION

1 Which of these categories best describes the way classes at this school are organized?

- ① Departmentalized instruction
- ② Taught by Subject Area Specialist (non-departmental)
- ③ Self-contained
- ④ Team taught

2 If your school is departmentalized, or you are a subject area specialist, how many different Science courses do you currently teach?

- ① ① ② ③ ④ ⑤ ⑥ ⑦
- (Number of courses taught)

### TARGET CLASS DESCRIPTION

**Selecting the Target Class—For all questions about instructional practices please refer only to activities in the Science class that you teach. If you teach more than one Science class, select the first class that you teach each week.**

3 Which term best describes the target class, or course, you are teaching?

- ① Other
- ② Elem..Middle. Sch Sci.
- ③ General Science
- ④ Life Science
- ⑤ Earth Science
- ⑥ Biology
- ⑦ Chemistry
- ⑧ Physics
- ⑨ Coordinated/Integrated

4 Indicate the grade level of the majority of students in the target class.

- ① K ① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

5 How many students are in the target class?

- ① 10 or less
- ② 11 to 15
- ③ 16 to 20
- ④ 21 to 25
- ⑤ 26 to 30
- ⑥ 31 or more

6 What percentage of the students in the target class are female? (Estimate to the nearest ten percent.)

- ① Less than 10 ② 10 ③ 20 ④ 30 ⑤ 40 ⑥ 50 ⑦ 60 ⑧ 70 ⑨ 80 ⑩ 90+ %

7 What percentage of the students in the target class are not Caucasian? (Estimate to the nearest ten percent.)

- ① Less than 10 ② 10 ③ 20 ④ 30 ⑤ 40 ⑥ 50 ⑦ 60 ⑧ 70 ⑨ 80 ⑩ 90+ %

- 8 During a typical week, approximately how many hours will the target class spend in Science instruction?
- ①   ①   ②   ③   ④   ⑤   ⑥   ⑦   ⑧   ⑨  
(Number of instructional hours)
- 9 What is the average length of each class period for this targeted Science class?
- ① Not applicable                      ④ 51 to 60 minutes  
① 30 to 40 minutes                      ⑤ 61 to 90 minutes  
② 41 to 50 minutes                      ⑥ 91 to 120 minutes  
③ Varies due to block scheduling or integrated instruction
- 10 How many weeks total will the target Science class/course meet for this school year?
- ①                      ①                      ②  
**Total # weeks =**    1 to 12                      13 to 24                      25 to 36
- 11 Estimate the achievement level of the majority of students in the target class, based on the national standards.
- ① High Achievement Levels  
② Average Achievement Levels  
③ Low Achievement Levels  
④ Mixed Achievement Levels
- 12 What percentage of students in the target class are Limited English Proficient (LEP)?  
(Estimate to the nearest ten percent.)
- ①   ①   ②   ③   ④   ⑤   ⑥   ⑦   ⑧   ⑨  
Less than 10   10   20   30   40   50   60   70   80   90+ %
- 13 What is considered most in scheduling students into this class?
- ① Ability or Achievement                      ③ Parent Request  
① Limited English Proficiency                      ④ No one factor more than another  
② Teacher Recommendation                      ⑤ Student selects

### **HOMEWORK (work assigned to be done *outside* of class)**

**Answer the following questions with regard to your target class:**

- 14 How often do you usually assign science homework to be done outside of class?
- ① Never (skip to #18)                      ③ 3-4 times per week  
① Less than once per week                      ④ Every day  
② Once or twice per week
- 15 How many minutes does the typical student spend on a normal homework assignment done outside of class?
- ① I do not assign homework                      ③ 31-60 minutes  
① Less than 15 minutes                      ④ 61-90 minutes  
② 15-30 minutes                      ⑤ More than 90 minutes
- 16 Does homework done outside of class count towards student grades?
- ① Never                      ③ Usually does  
① Usually does not                      ④ Always does
- 17 How often do you usually assign homework to be completed in a small group outside of class?
- ① Never (skip to #18)                      ③ 3-4 times per week  
① Less than once per week                      ④ Every day  
② Once or twice per week

**AMOUNT OF HOMEWORK TIME (for the school year)**

**0 – None**

**1 – Little** (10% or less of homework time for the school year)

**2 – Some** (11-25% of homework time for the school year)

**3 – Moderate** (26-50% of homework time for the school year)

**4 – Considerable** (50% of homework time for the school year)

**What percentage of the time that students in the target class spend on science homework done outside of class do you expect them to:**

	None	Little	Some	Moderate	Considerable
18 Read about science in books, magazines, or articles.	①	①	②	③	④
19 Answer questions from a science textbook or worksheet.	①	①	②	③	④
20 Solve science problems that require computation.	①	①	②	③	④
21 Revise and improve students' own work (for example, tests, homework assignments).	①	①	②	③	④
22 Collect data or information about science	①	①	②	③	④
23 Work on an assignment, report, or project that takes longer than one week to complete.	①	①	②	③	④
24 Write about science in a report/paper.	①	①	②	③	④

*Please continue on the next page.*

## INSTRUCTIONAL ACTIVITIES IN SCIENCE

Listed below are questions about the types of activities that students in the target class engage in during science instruction. For each activity, you are asked to estimate the relative amount of time a typical student will spend engaged in that activity over the course of the school year. The activities are not necessarily mutually exclusive; across activities, your answers will undoubtedly greatly exceed 100%. Consider each activity on its own, estimating the range that best indicates the relative amount of science instructional time that a typical student spends over the course of a school year engaged in that activity.

<b>AMOUNT OF INSTRUCTIONAL TIME (for the school year)</b>	
<b>0 – None</b>	
<b>1 – Little</b> (10% or less of instructional time for the school year)	
<b>2 – Some</b> (11-25% of instructional time for the school year)	
<b>3 – Moderate</b> (26-50% of instructional time for the school year)	
<b>4 – Considerable</b> (50% of instructional time for the school year)	

### How much of the total science instructional time do students in the target class:

	None ①	Little ①	Some ②	Moderate ③	Considerable ④
25 Listen to the teacher explain something to the class as a whole about science.	①	①	②	③	④
26 Read about science in books, magazines, articles ( <b>not</b> textbooks).	①	①	②	③	④
27 Work <i>individually</i> on science assignments.	①	①	②	③	④
28 Write about science in a report/paper on science topics.	①	①	②	③	④
29 Do a laboratory activity, investigation, or experiment.	①	①	②	③	④
30 Watch the teacher demonstrate a scientific phenomenon.	①	①	②	③	④
31 Collect data (other than laboratory activities).	①	①	②	③	④
32 Work <i>in pairs or small groups</i> (other than laboratory activities).	①	①	②	③	④
33 Do a science activity with the class outside the classroom or science laboratory (for example, field trips or research).	①	①	②	③	④
34 Use computers, calculators or other educational technology to learn science.	①	①	②	③	④
35 Maintain and reflect on a science portfolio of their own science work.	①	①	②	③	④
36 Take a quiz or test.	①	①	②	③	④

**AMOUNT OF INSTRUCTIONAL TIME (in laboratory activities, investigations, or experiments)****0 – None****1 – Little** (10% or less of instructional time in laboratory activities, investigations, or experiments)**2 – Some** (11-25% of instructional time in laboratory activities, investigations, or experiments)**3 – Moderate** (26-50% of instructional time in laboratory activities, investigations, or experiments)**4 – Considerable** (50% of instructional time in laboratory activities, investigations, or experiments)

**When students in the target class are engaged in *laboratory activities, investigations, or experiments* as part of science instruction, how much time do they:**

	None	Little	Some	Moderate	Considerable
37 Make educated guesses, predictions, or hypotheses.	①	①	②	③	④
38 Follow step-by-step directions.	①	①	②	③	④
39 Use science equipment or measuring tools.	①	①	②	③	④
40 Collect data.	①	①	②	③	④
41 Change a variable in an experiment to test a hypothesis.	①	①	②	③	④
42 Organize and display information in tables or graphs.	①	①	②	③	④
43 Analyze and interpret science data.	①	①	②	③	④
44 Design their own investigation or experiment to solve a scientific question.	①	①	②	③	④
45 Make observations/classifications.	①	①	②	③	④

*Please continue on the next page.*

**AMOUNT OF INSTRUCTIONAL TIME (in pairs or small groups)****0 – None****1 – Little** (10% or less of instructional time in pairs or small groups)**2 – Some** (11-25% of instructional time in pairs or small groups)**3 – Moderate** (26-50% of instructional time in pairs or small groups)**4 – Considerable** (50% of instructional time in pairs or small groups)

**When students in the target class are engaged in *pairs or small groups* (other than in the science laboratory), how much time do they:**

	None ①	Little ①	Some ②	Moderate ③	Considerable ④
46 Talk about ways to solve science problems, such as Investigations.	①	①	②	③	④
47 Complete written assignments from the textbook or workbook.	①	①	②	③	④
48 Write up results or prepare a presentation from a laboratory activity, investigation, experiment, or research project.	①	①	②	③	④
49 Work on an assignment, report, or project over an extended period of time.	①	①	②	③	④
50 Work on a writing project or entries for portfolios seeking peer comments to improve work.	①	①	②	③	④
51 Review assignments or prepare for a quiz or test.	①	①	②	③	④

**AMOUNT OF INSTRUCTIONAL TIME (collecting science data or information)****0 – None****1 – Little** (10% or less of instructional time collecting science data or information)**2 – Some** (11-25% of instructional time collecting science data or information)**3 – Moderate** (26-50% of instructional time collecting science data or information)**4 – Considerable** (50% of instructional time collecting science data or information)

**When students in the target class are engaged in *collect science data or information* from books, magazines, computers, or other sources (other than in the science laboratory), how much time do they:**

	None ①	Little ①	Some ②	Moderate ③	Considerable ④
52 Have class discussions about the data.	①	①	②	③	④
53 Organize and display the information in tables or graphs.	①	①	②	③	④
54 Make a prediction based on the data.	①	①	②	③	④
55 Analyze and interpret the information or data, orally or in writing.	①	①	②	③	④
56 Make a presentation to the class on the data, analysis, or interpretation.	①	①	②	③	④

**AMOUNT OF INSTRUCTIONAL TIME (using calculators, computers, or other ed. technology)****0 – None****1 – Little** (10% or less of instructional time using calculators, computers, or other ed. technology)**2 – Some** (11-25% of instructional time using calculators, computers, or other ed. technology)**3 – Moderate** (26-50% of instructional time using calculators, computers, or other ed. technology)**4 – Considerable** (50% of instructional time using calculators, computers, or other ed. technology)

**When students in the target class are engaged in activities that involve the use of calculators, computers, or other educational technology as part of science instruction, how much time do they:**

	None ①	Little ①	Some ②	Moderate ③	Considerable ④
57 Learn facts.	①	①	②	③	④
58 Practice procedures.	①	①	②	③	④
59 Use sensors and probes (for example, CBL's).	①	①	②	③	④
60 Retrieve or exchange data or information (for example, Using the Internet or partnering with another class).	①	①	②	③	④
61 Display and analyze data.	①	①	②	③	④
62 Solve problems using simulations.	①	①	②	③	④

**ASSESSMENTS**

**For items 63-70, indicate how often you use each of the following when assessing students in the target science class.**

	Never ①	1 - 4 times per year ①	1 - 3 times per month ②	1 - 3 times per week ③	4 - 5 times per week ④
63 Objective items (for example, multiple choice, true/false).	①	①	②	③	④
64 Short answer (for example, fill-in-the-blank).	①	①	②	③	④
65 Extended response item for which student must explain or justify solution.	①	①	②	③	④
66 Performance tasks or events (for example, hands-on activities).	①	①	②	③	④
67 Individual or group demonstration, presentation.	①	①	②	③	④
68 Science projects.	①	①	②	③	④
69 Portfolios.	①	①	②	③	④
70 Systematic observation of students.	①	①	②	③	④

## INSTRUCTIONAL INFLUENCES

For items 71-82, indicate the degree to which each of the following influences what you teach in the target science class.

	Not Applicable	Strong Negative Influence	Somewhat Negative Influence	Little or No Influence	Somewhat Positive Influence	Strong Positive Influence
71 Your state's curriculum framework or content standards.	①	②	③	④	⑤	
72 Your district's curriculum framework or guidelines.	①	②	③	④	⑤	
73 Textbook / instructional materials.	①	②	③	④	⑤	
74 State tests or results.	①	②	③	④	⑤	
75 District tests or results.	①	②	③	④	⑤	
76 National science education standards.	①	②	③	④	⑤	
77 Your experience in pre-service preparation.	①	②	③	④	⑤	
78 District mentor teachers.	①	②	③	④	⑤	
79 Other teacher colleagues.	①	②	③	④	⑤	
80 Students' special needs.	①	②	③	④	⑤	
81 Parents/community.	①	②	③	④	⑤	
82 Preparation of students for the next grade or level.	①	②	③	④	⑤	

*Please continue on the next page.*



**CLASSROOM INSTRUCTIONAL PREPARATION**

**For items 83-92, please indicate how well prepared you are to:**

	Not Well Prepared	Somewhat Prepared	Well Prepared	Very Well Prepared
83 Teach science at your assigned level.	①	①	②	③
84 Integrate science with other subjects.	①	①	②	③
85 Provide science instruction that meets science Content standards (district, state, or national).	①	①	②	③
86 Use a variety of assessment strategies (including objective and open-ended formats).	①	①	②	③
87 Manage a class of students who are using hands-on or laboratory activities.	①	①	②	③
88 Take into account students' prior conceptions about natural phenomena when planning.	①	①	②	③
89 Teach students with disabilities.	①	①	②	③
90 Teach classes with students with diverse abilities.	①	①	②	③
91 Teach science to students from a variety of backgrounds.	①	①	②	③
92 Teach science to students who have Limited English Proficiency.	①	①	②	③

*Please continue on the next page.*

## TEACHER OPINIONS

Please indicate your opinion about each of the statements below:

	Strongly Disagree	Disagree	Neutral / Undecided	Agree	Strongly Agree
93 Laboratory-based science classes are more effective than non-laboratory classes.	①	①	②	③	④
94 It is important for students to learn basic scientific terms and formulas before learning underlying concepts and principles.	①	①	②	③	④
95 I am supported by colleagues to try out new ideas in teaching science.	①	①	②	③	④
96 I am required to follow rules at this school that conflict with my best professional judgment about teaching and learning science.	①	①	②	③	④
97 Science teachers in this school regularly observe each other teaching classes.	①	①	②	③	④
98 Science teachers in this school trust each other.	①	①	②	③	④
99 It's OK in this school to discuss feelings, worries, and frustrations with other science teachers.	①	①	②	③	④
100 Science teachers respect other teachers who take the lead in school improvement efforts.	①	①	②	③	④
101 It's OK in this school to discuss feelings, worries, and frustrations with the principal.	①	①	②	③	④
102 The principal takes personal interest in the professional development of the teachers.	①	①	②	③	④

*Please continue on the next page.*

### PROFESSIONAL DEVELOPMENT ACTIVITIES IN SCIENCE EDUCATION

*In answering the following items, consider all the professional development activities related to science content or science education that you have participated in since you completed your certification program. Professional development refers to a variety of activities intended to enhance your professional knowledge and skills, including in-service training, teacher networks, course work, institutes, committee work, and mentoring. In-service training is professional development offered by your school or district to enhance your professional responsibilities and knowledge. Workshops are short term learning opportunities that can be located in your school or elsewhere. Institutes are longer term professional learning opportunities, for example, of a week or longer in duration.*

	How Often?					How many hours?					
	① Never	② Once	③ 3-4 times	④ 5-10 times	⑤ >10 times	① N/A	② 1-6 hrs.	③ 7-15 hrs.	④ 16-35	⑤ 36-60	⑥ 61+ hrs.
103 Since you completed your certification program, how often, and for how many total hours, have you participated in <i>workshops or in-service training related to science or science education</i> ?	①	②	③	④	⑤	①	②	③	④	⑤	⑥
104 Since you completed your certification program, how often, and for how many total hours, have you participated in <i>summer institutes related to science education</i> ?	①	②	③	④	⑤	①	②	③	④	⑤	⑥
105 Since you completed your certification program, how often have you attended college courses <i>related to science or science education</i> and about how many hours did you spend in class?	①	②	③	④	⑤	①	②	③	④	⑤	⑥

**Since you completed your certification program, how frequently have you engaged in each of the following activities related specifically to teaching and learning of science?**

	Never	Once or twice a year	Once or twice a term	Once or twice a month	Once or twice a week	Almost daily
106 Attended conferences related to science or science education.	①	②	③	④	⑤	⑥
107 Participated in teacher study group.	①	②	③	④	⑤	⑥
108 Participated in a teacher network, or collaborative of teachers supporting professional development.	①	②	③	④	⑤	⑥
109 Acted as a coach or mentor to other teachers or staff in your school.	①	②	③	④	⑤	⑥
110 Received coaching or mentoring.	①	②	③	④	⑤	⑥
111 Participated in a committee or task force focused on curriculum and instruction.	①	②	③	④	⑤	⑥
112 Participated in informal self-directed learning (for example, discussion with colleague about science or science education topics, read a journal article on science or science education, used the internet to enrich knowledge and skills).	①	②	③	④	⑤	⑥

**Thinking again about all of your professional development activities in science or science education since you completed your certification program, how often have you:**

	Never	Rarely	Sometimes	Often
113 Observed demonstrations of teaching techniques.	①	①	②	③
114 Led group discussions.	①	①	②	③
115 Developed curricula or lesson plans, which other participants or the activity leader reviewed.	①	①	②	③
116 Reviewed student work or scored assessments.	①	①	②	③
117 Developed assessments or tasks.	①	①	②	③
118 Practiced what you learned and received feedback.	①	①	②	③
119 Received coaching or mentoring in the classroom.	①	①	②	③
120 Gave a lecture or presentation to colleagues.	①	①	②	③

**Thinking about all of your professional development activities in science or science education since you completed your certification program, indicate how often they have been:**

	N/A	Never	Rarely	Sometimes	Often
121 Designed to support the school-wide improvement plan adopted by your school.	①	①	①	②	③
122 Consistent with your science department or grade level plan to improve teaching.	①	①	①	②	③
123 Consistent with your own goals for your professional development.	①	①	①	②	③
124 Based explicitly on what you had learned in earlier professional development activities.	①	①	①	②	③
125 Followed up with related activities that built upon what you learned as part of the activity.	①	①	①	②	③

**Since you completed your certification program, have you participated in professional development activities in science or science education in the following ways?**

	<b>No</b>	<b>Yes</b>
126 I participated in professional development activities with most or all of the teachers from my school.	①	①
127 I participated in professional development activities with most or all of the teachers from my department or grade level.	①	①
128 I participated in professional development activities <i>not</i> attended by other staff members from my school.	①	①
129 I discussed what I learned with other teachers in my school or department who did <i>not</i> attend the activity.	①	①

**How much *emphasis* did your professional development activities in science or science education place on the following topics?**

	<b>None</b>	<b>Slight</b>	<b>Moderate</b>	<b>Great</b>
130 State science content standards (for example, what they are and how they are used).	①	①	②	③
131 Alignment of science instruction to curriculum.	①	①	②	③
132 Instructional approaches (for example, use of manipulatives).	①	①	②	③
133 In-depth study of science or specific concepts within science (for example, earth science).	①	①	②	③
134 Study of how children learn particular topics in science.	①	①	②	③
135 Individual differences in student learning.	①	①	②	③
136 Meeting the learning needs of special populations of students (for example, second language learners; students with disabilities).	①	①	②	③
137 Classroom science assessment (for example, diagnostic approaches, textbook-developed tests, teacher-developed tests).	①	①	②	③
138 State or district science assessment (for example, preparing for assessments, understanding assessments, or interpreting assessments).	①	①	②	③
139 Interpretation of assessment data for use in science instruction.	①	①	②	③
140 Technology to support student learning in science.	①	①	②	③

## TEACHER CHARACTERISTICS

141 Please indicate your gender.	Female ①	Male ①					
142 Please indicate your ethnicity/race. <b>INDICATE ALL THAT APPLY</b>	① American Indian or Alaska Native ② Asian ③ Black or African American ④ Hispanic or Latino ⑤ Native Hawaiian or Other Pacific Islander ⑥ White						
	Less than 1 year	1 - 2 years	3 - 5 years	6 - 8 years	9 - 11 years	12 - 15 years	More than 15 years
143 How many years have you taught science prior to this year?	①	①	②	③	④	⑤	⑥
144 How long have you been assigned to teach at your current school?	①	①	②	③	④	⑤	⑥
	Does not apply	BA or BS	MA or MS	Multiple MA or MS	Ph.D. or Ed.D.	Other	
145 What is the highest degree you hold?	①	①	②	③	④	⑤	
146 What was your major field of study for Bachelors degree?	① Elementary Education ② Middle School Education ③ Science Education ④ Science ⑤ Science Education and Science ⑥ Other Disciplines (includes other Education fields, History, English, Foreign Languages, etc.)						
147 <b>If applicable</b> , what was your <b>major field</b> of study for the <b>highest degree you hold</b> beyond a bachelors degree?	① Elementary Education ② Middle School Education ③ Science Education ④ Science ⑤ Science Education and Science ⑥ Other Disciplines (includes other Education fields,						
148 What type(s) of state certification do you currently have? <b>INDICATE ALL THAT APPLY</b>	① Emergency or Temporary Certification ② Elementary Grades Certification ③ Middle Grades Certification ④ Secondary certification in a field other than science ⑤ Secondary science certification						

**FORMAL COURSE PREPARATION**

Please indicate the number of *quarter or semester courses* that you have taken at the undergraduate or graduate level in each of the following areas:

	(Number of courses)									
	0	1-2	3-4	5-6	7-8	9-10	11-12	13-14	15-16	17+
149 Biology / Life Science	①	①	②	③	④	⑤	⑥	⑦	⑧	⑨
150 Physics / Chemistry / Physical Science	①	①	②	③	④	⑤	⑥	⑦	⑧	⑨
151 Geology / Astronomy / Earth Science	①	①	②	③	④	⑤	⑥	⑦	⑧	⑨
152 Science Education	①	①	②	③	④	⑤	⑥	⑦	⑧	⑨

**This is the end of the Curriculum Survey.**  
**Thank you for your time and honest answers while completing this survey.**  
**Please return the survey to:**  
**IMPACT Project**  
**103A Heroy Laboratory**  
**Syracuse, NY 13244**

## Appendix C NSTEPG

### IMPACT Project Survey of Teacher Education Program Graduates



PLEASE PROVIDE THE FOLLOWING:

Name: \_\_\_\_\_  
                                     Last                                    First                                    Middle                                    Former

Address: \_\_\_\_\_  
   Street                                    City                                    State                                    Zip

#### SECTION I DEMOGRAPHIC DATA

[Reminder: all demographic data will be confidential and only reported as aggregate data for the study reports.]

(PLEASE CIRCLE YOUR RESPONSES)

1. What is your ethnic background?
 

(1) American Indian or Alaskan	(4) Hispanic
(2) Asian or Pacific Islander	(5) White, non-Hispanic
(3) Black, non-Hispanic	(6) Other
2. What is the highest degree or highest level of education you hope to attain?
 

(1) BS degree	(2) master's degree
(3) specialist's degree/certificate of advanced study	(4) Ed.D., Ph.D., or other advanced degree
3. In what year did you graduate from your teacher preparation program?  
 \_\_\_\_\_

#### SECTION II EMPLOYMENT STATUS

Circle **ALL** options A through E that apply to you, and complete sections indicated:

- A. I am employed in the field of education. **(Please complete through #4 of this section; then answer All Sections EXCEPT VI on Page 4)**
  4. How would you describe your current position in education?
 

(1) full-time teacher	(5) educational specialist (e.g., librarian, counselor)
(2) permanent substitute	(6) school administrator/supervisor
(3) part-time teacher	(7) other
(4) day-to-day substitute	

- B. I am employed outside the field of education. **(Please complete through #5 of this section; then go to Page 4 Section VI and answer all questions from there on)**

Employment \_\_\_\_\_

Job Title \_\_\_\_\_

Name of Organization \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

Phone \_\_\_\_\_

Salary \_\_\_\_\_  
 (Confidential; for statistical compilation only)

5. To what extent is your position connected to your most recent degree?

- (1) Directly connected
- (2) Moderately connected
- (3) Slightly connected
- (4) Not connected

- C. I am in graduate/professional school. **(Please Proceed to Section VII on Page 4)**

University \_\_\_\_\_

Academic Program \_\_\_\_\_

- D. I am not seeking employment currently. **(Please Proceed to Section VII on Page 4)**
- E. I am not employed and still job hunting. **(Please Proceed to Section VII on Page 4)**



**SECTION III****FOR GRADUATES WHO ARE TEACHING:  
INFORMATION ABOUT YOUR TEACHING POSITION**

6. At what grade level do you teach?
- (1) preschool (4) middle school/jr. high  
(2) early elem. (grades K-3) (5) senior high school  
(3) upper elem. (grades 4-6) (6) more than one level/K-12
7. About what percent of your present teaching assignment is in the grade(s) or subject area(s) in which you were certified/endorsed?
- (1) 25% or less (3) 75%  
(2) 50% (4) 100%
- 8-10. How would you describe your school building?
8. Type: 9. Setting: 10. Number of Students:
- (1) public (1) inner-city (1) less than 300  
(2) parochial (2) urban (pop. > 100,000) (2) 300 to 599  
(3) private (3) suburban (3) 600 to 899  
(4) town (pop. > 25,000) (4) 900 to 1,200  
(5) small town/rural (5) more than 1,200
11. Is the school in which you teach located within 50 miles of the...
- (1) high school from which you graduated  
(2) college from which you received your teacher preparation  
(3) both of the above  
(4) neither of the above
12. Are the socioeconomic backgrounds of most of your current students lower, higher, or similar to those of your high school classmates?
- (1) lower (2) higher (3) similar
13. Approximately what proportion of the students in your class(es) are students of color?
- (1) less than 10% (3) 25% (5) 75%  
(2) 10% (4) 50% (6) more than 75%
14. Is this percentage lower, higher, or comparable to the proportion of students of color in your high school class?
- (1) lower (2) higher (3) comparable
15. Are you a special education teacher?
- (1) Yes If no, have you experienced inclusion in your classroom(s)?  
(2) yes, of one or two students (4) none  
(3) yes, of more than two students
16. How would you characterize the level of academic motivation of your students?
- (1) very low (3) average (5) very high  
(2) low (4) high
17. How would you characterize the frequency of discipline problems in your class(es)?
- (1) few, if any, problems (3) many problems  
(2) occasional problems

18. How would you characterize the level of parent involvement in your school?

(1) very low (3) not sure (5) very high  
(2) low (4) high

- 19-23. **Management Practices:** Which of the following management practices does your school feature?

**Circle all applicable answers.**

18. Outcomes based management  
19. Principal manages decisions  
20. School governing board (including parents & other community representatives)?  
21. Site-based management  
22. Teacher-principal shared decision making and/or teacher empowerment

24. **School's Vision:** Does your school have a clear vision of what you want your students to know and be able to do by the time they graduate?

- (1) No  
Yes -- If Yes, were you in any way involved in the creation of this vision?  
(2) No  
(3) Yes, I was somewhat involved.  
(4) Yes, I was actively involved.  
(5) Yes, I played a significant role in the creation of the vision.

**SECTION IV****FOR GRADUATES WHO ARE TEACHING:  
VIEWS OF TEACHING**

25. Which of the following criteria are you most likely to consider when assessing your success as a teacher? The extent to which students...
- (1) like and respect me as a teacher.  
(2) learn what I try to teach them.  
(3) gain a sense of self-confidence and self-worth in my classroom.  
(4) get along with each other.
26. Student behavior problems may result from a number of different sources, including those listed below. Which of these would you rank as the most frequent source of student behavior problems in classroom settings?
- (1) teachers' inadequate planning/classroom management  
(2) teachers/failure to establish a supportive classroom environment  
(3) unresolved problems students experience outside the classroom setting  
(4) conflicts between values students acquire at home and those that are prized in schools  
(5) parents' failure to support teachers/schools
27. In adapting instruction to address differences in students' academic achievement, are you most likely to vary the...
- (1) content you teach to different students  
(2) instructional methods you use with different students  
(3) standards of achievement you expect students to attain (higher standards for more capable students)?

28. Which of the following questions is most likely to occur to you when you are trying to decide what content to teach or what not to teach? Will knowing this content help students...
- (1) succeed in later grades or later courses in this subject area?
  - (2) pass state or district tests?
  - (3) acquire the practical knowledge base they will need to function effectively as adults in our society?
  - (4) understand the people and events that are currently shaping their lives?
  - (5) enjoy richer or more meaningful adult lives?
29. Do you believe you can reach even the most difficult or least motivated students?
- (1) Yes
  - (2) No
  - (3) Yes, with some qualifications
  - (4) No, with some qualifications
30. If students seem puzzled or confused at some point during a lesson, what are you most likely to do?
- (1) try to resolve the confusion by providing a clearer example or better explanation.
  - (2) provide sufficient support for students to work through the source of the confusion on their own.
  - (3) downplay the seriousness of their confusion so students won't become discouraged.
31. When students fail to achieve intended goals and objectives, that failure is often attributed to one of the following sources. Which do you believe is the most frequent source of failure?
- (1) students' home background
  - (2) students' indifference or lack of motivation
  - (3) parents' failure to stress the importance of school
  - (4) teachers' use of inappropriate methods of teaching
  - (5) teachers' failure to consider the unique interests and abilities of students
- 32-39. On a scale of one to seven, how would you describe your response to each of the following features of your current job?
- |  | (1) very negative | (2) | (3) | (4) | (5) | (6) | (7) very positive |
|--|-------------------|-----|-----|-----|-----|-----|-------------------|
| 32. Salary/fringe benefits                                       | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
| 33. Opportunities for professional advancement                   | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
| 34. Level of personal/professional challenge                     | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
| 35. Level of professional autonomy/decision making authority     | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
| 36. General work conditions (hours, class size, work load, etc.) | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
| 37. Interactions with colleagues                                 | 1                 | 2   | 3   | 4   | 5   | 6   | 7                 |
38. Interactions with students
39. *Using the same scale*, how would you describe your overall level of satisfaction with your current job?
40. If you had it to do all over again, would you still enroll in a teacher education program?
- (1) definitely no
  - (2) probably no
  - (3) probably yes
  - (4) definitely yes
41. Do you feel you are a(n) ...
- (1) inferior teacher
  - (2) below average teacher
  - (3) average teacher
  - (4) better than average teacher
  - (5) exceptional teacher
42. How would you characterize your district's commitment to teachers' professional development (e.g., providing inservice workshops; making available professional materials)?
- (1) very low
  - (2) low
  - (3) not sure
  - (4) high
  - (5) very high
43. Which of the following activities is most likely to help you become a better teacher? **(Choose One)**
- (1) Observe other teachers and talk to them.
  - (2) Be observed by other teachers or supervisors and talk with them.
  - (3) Read professional journals/publications.
  - (4) Take additional graduate courses in education.
  - (5) Take additional graduate courses in the subjects you teach.
  - (6) Participate in teacher inservices/workshops.
44. Which of the following activities is least likely to help you become a better teacher? **(Choose One)**
- (1) Observe other teachers and talk to them.
  - (2) Be observed by other teachers or supervisors and talk with them.
  - (3) Read professional journals/publications.
  - (4) Take additional graduate courses in education.
  - (5) Take additional graduate courses in the subjects you teach.
  - (6) Participate in teacher inservices/workshops.
45. Do you have ready access to a personal computer in your school?
- (1) No
  - (2) If yes, how do you use computers in your teaching?
  - (3) not at all
  - (4) as a tool in teaching or reinforcing student learning (e.g., in teaching writing or math).
  - (5) for my own record keeping, preparation of instructional handouts, etc.
  - (6) both of the above
46. What other kinds of technology do you use in your teaching? **(Circle all that apply)**
- (1) Videoconferencing
  - (2) Graphing calculators/labs
  - (3) Probes
  - (4) Computer simulations
  - (5) Laser disks
  - (6) LCD panel
  - (7) Overhead projector
  - (8) Video camera
  - (9) Global Positioning System (GPS)
  - (10) Geographic Information System (GIS)
  - (11) Digital video editing
  - (12) Webpage Design
  - (13) Internet applications
  - (14) Personal Data Assistant (PDA)
  - (15) Course management software (eg. webCT)
  - (16) iPod
  - (17) Other: \_\_\_\_\_

## SECTION V

### FOR GRADUATES WHO ARE TEACHING: CAREER SATISFACTION AND PROFESSIONAL DEVELOPMENT

47. Five years from now, do you plan to be...
- (1) teaching
  - (2) a school administrator
  - (3) an educational specialist (e.g. math consultant, librarian)
  - (4) employed outside the field of education
  - (5) temporarily out of the work force (e.g., care for a family)
  - (6) permanently out of the work force (e.g., retired)
  - (7) counselor/school psychologist
  - (8) other

48. To what extent were college courses in the subject(s) you currently teach relevant to the needs of teachers?

- (1) largely irrelevant
- (2) moderately relevant
- (3) very relevant

49. Consider your daily teaching and learning activities. Are these teaching and learning activities that you perceive to promote life long learning?

- (1) definitely not
- (2) probably not
- (3) not sure
- (4) probably yes
- (5) definitely yes

50. Consider your knowledge, skills and abilities as a teacher. Would you recommend your science teacher education program to other prospective teachers?

- (1) definitely not
- (2) probably not
- (3) not sure
- (4) probably yes
- (5) definitely yes

GO TO SECTION VII #56

#### **SECTION VI** (For Those Who Circled B On Page 1)

##### **FOR GRADUATES WHO ARE NOT TEACHING**

51. Which of the following statements best describes why you are not in a full-time teaching position at the present time?
- (1) Teaching was not my first choice of careers at the time I began looking for a job.
  - (2) I was offered another job within the field of education (e.g., school administrator).
  - (3) I was offered another job outside of education.
  - (4) A full-time teaching position was not available in the geographic area where I hoped to reside.
  - (5) I tried, but I couldn't find a full-time teaching position anywhere.
  - (6) I wanted to continue my education.
  - (7) I needed to attend to home/family affairs.
  - (8) Other
52. Do you regret you are not a full-time teacher?
- (1) Yes
  - (2) No
53. Do you feel you are underemployed?
- (1) Yes
  - (2) No
54. To what extent did the work you completed in your teacher education program contribute to your preparation for your current job?
- (1) no contribution
  - (2) minor contribution
  - (3) moderate contribution
  - (4) strong contribution

55. If you had it to do all over again, would you still enroll in a teacher education program?

- (1) definitely not
- (2) probably not
- (3) probably yes
- (4) definitely yes

#### **SECTION VII**

##### **ALL GRADUATES: RATINGS OF PRESERVICE PROGRAM QUALITY**

- 56-71. On a scale of one to seven, how would you rate the overall quality of your preservice science teacher education program...

	(1) exceptionally weak			(7) exceptionally strong			
56. field-based experiences	1	2	3	4	5	6	7
57. diverse field placements	1	2	3	4	5	6	7
58. program major	1	2	3	4	5	6	7
59. multiple courses in the methods of teaching science	1	2	3	4	5	6	7
60. research-based rationale and defense	1	2	3	4	5	6	7
61. action research project	1	2	3	4	5	6	7
62. extensive training and use of educational technology	1	2	3	4	5	6	7
63. coursework on science, technology, and society (STS)	1	2	3	4	5	6	7
64. coursework on the nature of science (NOS)	1	2	3	4	5	6	7
65. instructional resources i.e., library	1	2	3	4	5	6	7
66. your student teaching/internship experience	1	2	3	4	5	6	7
67. feedback from cooperating teachers/mentors	1	2	3	4	5	6	7
68. feedback from college coordinators/supervisors/faculty	1	2	3	4	5	6	7
69. advice/counseling from your academic advisor	1	2	3	4	5	6	7
70. advice/counseling from your faculty advisor	1	2	3	4	5	6	7
71. completing the program as a cohort	1	2	3	4	5	6	7
72. To what extent did your views of the professional roles and responsibilities of teachers change from the time you entered your teacher preparation program to program completion?	(1) not at all			(3) some			
	(2) not much			(4) a lot			

73. Please rate your overall capability compared with other professionals with the same number of years experience in your professional practice.

- (1) very low                      (4) above average  
(2) low                              (5) very high  
(3) average

74. Please rate your overall confidence in your professional practice.

- (1) very low                      (4) above average  
(2) low                              (5) very high  
(3) average

75. Please rate your overall professional behavior.

- (1) very low                      (4) above average  
(2) low                              (5) very high  
(3) average

76. Overall, rate the quality of your courses.

- (1) unacceptable                  (4) above average  
(2) below average                  (5) exceptional  
(3) average

77. The intellectual challenge of your course work.

- (1) unacceptable                  (4) above average  
(2) below average                  (5) exceptional  
(3) average

78. The quality of instruction you received during your course work.

- (1) unacceptable                  (4) above average  
(2) below average                  (5) exceptional  
(3) average

79. The quality of your cooperating/placement teacher.

- (1) unacceptable                  (4) above average  
(2) below average                  (5) exceptional  
(3) average

80. The OVERALL quality of your University teacher education experience.

- (1) unacceptable                  (4) above average  
(2) below average                  (5) exceptional  
(3) average

81-107. How would you have rated the adequacy of your skills in each of the following areas at the time you completed your teacher preparation program: (1) weak, (2) adequate, or (3) strong?

**The adequacy of your skills in . . .                  weak    adequate    strong**

- |   |   |   |   |
|---|---|---|---|
| 81. planning stimulating lessons.   | 1 | 2 | 3 |
| 82. motivating students to participate in academic tasks.   | 1 | 2 | 3 |
| 83. teaching basic knowledge and skills.  | 1 | 2 | 3 |
| 84. teaching problem solving and higher-order thinking to all students                              |   |   |   |
| (a) in science and mathematics (elementary teachers).   | 1 | 2 | 3 |
| (b) in the most challenging subject you teach (secondary teachers).                                 | 1 | 2 | 3 |
| 85. teaching problem solving, conceptual understanding, and other aspects of higher-order thinking. | 1 | 2 | 3 |

**The adequacy of your skills in . . .                  weak    adequate    strong**

- |  |   |   |   |
|--|---|---|---|
| 86. developing a "sense of community" among the students in your classroom (i.e., a classroom that stresses meaningful collaborations among students). | 1 | 2 | 3 |
| 87. team teaching and/or interdisciplinary planning and teaching.  | 1 | 2 | 3 |
| 88. selecting, preparing, and using educational media.   | 1 | 2 | 3 |
| 89. using educational technology as a learning tool  | 1 | 2 | 3 |
| 90. referring students for special assistance when appropriate.  | 1 | 2 | 3 |
| 91. working with gifted and talented students.   | 1 | 2 | 3 |
| 92. working in an inclusion setting or with special needs students.  | 1 | 2 | 3 |
| 93. using literature-based approaches to instruction (e.g., using literary works to teach social studies).   | 1 | 2 | 3 |
| 94. working with students from diverse racial and ethnic backgrounds.  | 1 | 2 | 3 |
| 95. adapting instruction to address differences in students/academic aptitude.   | 1 | 2 | 3 |
| 96. enhancing students' sense of personal achievement and self-worth.  | 1 | 2 | 3 |
| 97. monitoring students' progress and adjusting instruction accordingly.   | 1 | 2 | 3 |
| 98. designing/interpreting measures of student work and achievement.   | 1 | 2 | 3 |
| 99. using alternative assessment practices--portfolios, performance tests, student self-assessment strategies, etc).                                   | 1 | 2 | 3 |
| 100. communicating with parents.   | 1 | 2 | 3 |
| 101. using the community as a resource for teaching and learning.  | 1 | 2 | 3 |
| 102. using jigsaw, Teams-Games-Tournaments (TGT), and other cooperative learning techniques.   | 1 | 2 | 3 |
| 103. responding appropriately to disruptive student behaviors.   | 1 | 2 | 3 |
| 104. assessing the expectations of the community and school administration.  | 1 | 2 | 3 |
| 105. designing lessons and units of instruction that feature multiple representations of concepts.   | 1 | 2 | 3 |
| 106. designing lessons and units of instruction that feature multiple perspectives (e.g., a genetics unit on the bioethics of cloning).                | 1 | 2 | 3 |

**The adequacy of your skills in . . .**      **weak    adequate    strong**

- |      |  |   |   |   |
|------|--|---|---|---|
| 107. | planning and implementing a successful first week of school. | 1 | 2 | 3 |
| 108. | reflecting upon and improving your teaching performance.     | 1 | 2 | 3 |

109. What kinds of technology were you prepared (during your program) to use in your teaching? **(Circle all that apply)**

- |  |   |
|--|---|
| (1) Videoconferencing                    | (11) Digital video editing                  |
| (2) Graphing calculators/labs            | (12) Webpage Design                         |
| (3) Probes                               | (13) Internet applications                  |
| (4) Computer simulations                 | (14) Personal Data Assistant (PDA)          |
| (5) Laser disks                          | (15) Course management software (eg. webCT) |
| (6) LCD panel                            | (16) iPod                                   |
| (7) Overhead projector                   | (17) Other: _____                           |
| (8) Video camera                         |   |
| (9) Global Positioning System (GPS)      |   |
| (10) Geographic Information System (GIS) |   |

110-129. How would you rate the adequacy of your knowledge and understanding in each of the following areas?

<u>Your knowledge and understanding of ...</u>	<b>weak</b>	<b>adequate</b>	<b>strong</b>
110. curriculum development	1	2	3
111. special needs children	1	2	3
112. communication	1	2	3
113. educational research	1	2	3
114. child development	1	2	3
115. multi-cultural issues and perspectives	1	2	3
116. the historical and philosophical development of thought in your major field	1	2	3
117. contemporary educational issues	1	2	3
118. theories/principles of how students learn	1	2	3
119. child/adolescent growth and development	1	2	3
120. social and political roles of schools in American society	1	2	3
121. classroom management techniques/procedures	1	2	3
122. legal and ethical responsibilities of teachers	1	2	3
123. the subjects you teach.	1	2	3
124. educational concepts and theories.	1	2	3
125. classroom research/inquiry strategies	1	2	3
126. measurement techniques	1	2	3
127. recent research in education.	1	2	3
128. professional practice/pedagogy.	1	2	3
129. a variety of assessment strategies	1	2	3

Thank you for the time and effort to complete this study!!!

The IMPPACT Project researchers respect your opinion and feedback.

**Appendix D**  
**Introductory Interview Protocol**

1. Tell me about why you decided to become a teacher.
2. Thinking back, what was the best science teaching you ever experienced?
3. In what ways, if any, has that experience affected your own teaching?
4. In contrast, what was the worst science teaching you ever experienced?
5. How did that experience affect your teaching?
6. Why did you select Iowa / NC State / Syracuse for your science teacher education program?

**COHORTS 1 & 2 STOP HERE**

**COHORTS 3 & 4 ONLY**

---

7. How prepared were you to start teaching?
8. What would have made you better prepared?
9. What lessons have you learned from your teaching experiences thus far?

**Appendix E**  
**Pre-Service Program Interview Protocol**  
**IMPPACT Project Preservice Program Interview**  
**Teacher Form**

**1. How would you describe your typical science course?**

*Probe for:*

- a. Types of objectives, e.g., certain knowledge, specific skills, attitudes towards science.
- b. Typical instructional strategies, e.g., lecture, labs, projects, seminar discussion, independent research, cooperative learning, etc.
- c. Instructional resources, e.g., textbooks, instrumentation, technologies, etc.

**2. How were you typically evaluated in science courses?**

*Probe for:*

- a. Written tests;
- b. Essays;
- c. Projects;
- d. Oral presentations;
- e. Research performance;
- f. Homework assignments
- g. Evaluation by peers.

**3. How often were cooperative learning techniques used in your science courses?**

**4. Did you take science courses different from those taken by students not preparing to each?**

**5. How often did you work on actual research projects or in actual research facilities as part of your science program?**

*Probe for:* Nature and duration of field experiences

**6. Which science courses, or experiences, stand out in your mind as particularly important to you? Why?**

*Probe for:*

- a. What was learned.
- b. Specific instructional strategies.
- c. Materials used.
- d. Ways of evaluating student learning.
- e. Course organization, e.g., cooperative learning.

**7. How would you describe the student-faculty relationship in your science program?**

**8. Were you a member of a student cohort when studying science?**

**9. What was the purpose of your science study? Did it include teaching as a career?**

**Teacher Education Study**

**10. How would you describe your typical teacher education course?**

***Probe for:***

- a. Types of objectives, e.g., certain knowledge, specific skills, attitudes toward science or teaching secondary school students.
- b. Typical instructional strategies, e.g., lecture, labs, projects, seminar discussion, independent research, cooperative learning, etc.
- c. Instructional resources, e.g., textbooks, instrumentation, technologies, etc.

**11. How were you typically evaluated in teacher education courses?**

***Probe for:***

- a. Written tests;
- b. Essays;
- c. Projects;
- d. Oral presentations;
- e. Teaching performance;
- f. Homework assignments
- g. Evaluation by peers or faculty.

**12. How often were cooperative learning techniques used in your teacher education courses?**

**13. How would you describe your field experiences?**

***Probe for:***

- a. Experiences in different schools or school settings.
- b. What students did in field experiences.
- c. Nature of supervision and evaluation.

**14. Which courses, or experiences, stand out in your mind as particularly important to you? Why?**

***Probe for:***

- a. What was learned.
- b. Specific instructional strategies.
- c. Materials used.



- d. Ways of evaluating student learning.
- e. Course organization, e.g., cooperative learning.

**15. What was the relationship between what you learned in science courses, and what you learned in teacher education courses, including your methods courses?**

**16. How would you describe the student-faculty relationship in your teacher education program?**

**17. Were you a member of a student cohort in your teacher education program?**

Salish I Research Project

Preservice Program Interview

New Teacher Form

IMPPACT Rev: Feb 2008

## Appendix F RoPPE Interview Protocol

### IMPPACT Project

#### Reflection on Preservice Program Experiences (RoPPE) Interview

Thank you for taking the time for this interview today. We want to remind you how important your thoughts and ideas are to the IMPPACT Project.

There are no right or wrong answers to the interview questions I am about to ask you. I am interested in your personal views concerning each of the topics. As always, please be candid in your responses as this information is strictly confidential.

Do you have any questions before we begin?

#### Teacher Education- Science Education Experiences

*For the first question I would like you to reflect specifically on the science education courses in your preservice program. We will discuss your student teaching and field experiences later in the interview.*

[**For researcher only:** at NC this would be EMS courses (methods of teaching Science, seminar, instructional materials); at Iowa this would be 7S courses of similar content as well as instructional issues course; at SU this would be SCE courses (teacher development, NOS)]

#### 1. What experiences within your science education courses have influenced your beliefs and practices as a teacher?

*Probe for how they have shaped their knowledge about:*

- a. teaching;
- b. the ways to assess students;
- c. how students learn;
- d. lesson/unit planning and/or curriculum implementation;
- e. subject matter.

*Now I'm going to ask you a series of questions about SPECIFIC features of science teacher education programs. If any of the questions do not apply to you, just say so, and we will move on to the next question.*

*For these questions, I would like you to tell me about how features of your teacher education program helped shape your beliefs and practices as a classroom teacher. By beliefs, I mean your ideas or thoughts on effective teaching and learning, and by practices, I mean what you actually do in the classroom.*

- 2a. How has completing your preservice program as part of a cohort of students shaped your beliefs and practices?**
- 2b. How has developing a research-based rationale paper and orally defending it shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2c. How has conducting action research shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2d. How has learning about the Nature of Science (NOS) shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2e. How has your preparation in the use of educational technology shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2f. How has learning how to reflect on your practice (e.g. videotape analysis, microteaching, and/or lesson study) shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2g. How has taking multiple courses in the methods of teaching science shaped your beliefs about effective teaching and learning and your actual classroom practices?**
  - 2gi. Were your science methods courses taught for all sciences combined or were they specific to your discipline (physics, biology, chemistry, earth science)?**
  - 2gii. How many methods courses did you have?**
- 2h. How has learning about the links between Science-Technology-Society (STS) shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 2i. How have your applications of science courses shaped your beliefs about effective teaching and learning and your actual classroom practices?**
- 3. What suggestions would you make to improve the quality of the learning experiences in your science teacher education courses?**

*Probe for:*

- a. specific kinds of experiences that would be beneficial for future science teachers.

- 4. What research-based practices do you typically use in your teaching?**

## Teacher Education- Field Experiences/Student Teaching

*Now I would like you to reflect specifically on the field experiences/student teaching component of your preservice program.*

**5. To what extent have your field experiences and student teaching placements influenced your beliefs and classroom practices as a teacher?**

*Probe for how they have shaped their:*

- a. teaching;
- b. the ways to assess students;
- c. how students learn;
- d. lesson/unit planning and/or curriculum implementation;
- e. subject matter.

**6. In what ways, if any, did the variety or diversity of the field placements you experienced influence your beliefs and practices as a science teacher?**

*NOTE: Allow interviewee to define what diversity is.*

**7. How have your experiences with your host teachers shaped your beliefs about effective teaching and learning and your actual classroom practices?**

**8. What suggestions would you make to improve the quality of the learning experiences in these field placements for preservice science teachers?**

*Probe for:*

- a. specific kinds of specific experiences that would be useful for future science teachers.

### External Factors Influencing Beliefs and Practices

**9. Since the time you graduated from your preservice program, what other factors may have significantly influenced your beliefs and classroom practices as a teacher?**

*NOTE: If interviewee has not graduated yet, rephrase question appropriately.*

*Probe for how any of the following may have shaped their beliefs and practices:*

- a. school culture;
- b. peer teacher influence;
- c. external factors such as state exams and curricula;
- d. mentoring experiences;
- e. professional development experiences.

**10. How has the No Child Left Behind legislation influenced your beliefs and practices? How well did your preservice program prepare you to address these types of expectations?**

### Other Thoughts

**11. How well do you feel that your pre-service science teacher education adequately prepared you for your teaching position?**

- 12. What do you think contributes to the high rate of teacher attrition for beginning science teachers?**
- 13. Do you have any other thoughts you would like to share about your pre-service science teacher education program?**

**Appendix G**  
**BNOS Interview Protocol**

**IMPPACT Project**  
**Beliefs/Nature of Science Interview Map**  
**In-Service Teacher Form**  
**Context Statement for Beliefs/NOS Interview**

Thank you for taking the time for this interview today. We always want to remind you how important your thoughts and ideas are to the IMPPACT Project.

There are no right or wrong answers to the interview questions I am about to ask you. I am interested in your personal views concerning each of the topics. As always, please be candid in your responses as this information is strictly confidential. In addition, some of the questions are similar to each other, so you may feel a question is asked twice. If you want to skip anything, let me know.

Do you have any questions before we begin?

1. How do you maximize student learning in your classroom?
  - 1a. Tell me specifically about how you organize your classroom to support student learning.
  - 1b. Tell me specifically about what type of classroom environment you create to promote student learning.
  - 1c. Describe the instructional techniques that you employ to maximize student learning.
2. How do you describe your role as a teacher?
3. How do you know when your students understand a concept?
4. In what ways, if any, has the school environment or culture influenced your beliefs and actions as a teacher?
 

Let's pursue this further in a few ways...

  - 4a-i. To what extent, if any, have the relationships between you and other teachers influenced your beliefs and actions?
  - 4a-ii. To what extent, if any, have the relationships between you and your students influenced your beliefs and actions?
  - 4a-iii. To what extent, if any, have the relationships between you and administrators in your school influenced your beliefs and actions?

- 4b. What can you tell me about any mentoring you might have received? Has this experience influenced your beliefs and actions in any way?
- 4c. How would you characterize the District's philosophy toward science education reform? Has this influenced your beliefs and actions in any way?
- 4d. How would you describe the school-community relationship in your district? Has this influenced your beliefs and actions in any way?
- 5. In your school setting, how do you decide what to teach or what not to teach?
- 6. How do you decide when to move on to a new topic in your class?
- 7. How do your students learn best?
- 8. How do you know when learning is occurring in your classroom?

## Appendix H

Table H1

*Teachers Report of Amount of Time per School Year Spent Engaging Students in Instructional Activities in Science*

Instructional Activity	n (%)				
	None	Little (10% or less)	Some (11-25%)	Moderate (26 – 50 %)	Considerable (at least 50%)
22) Collect data or information about science (as a part of homework)	17 (14.2)	42 (35)	35 (29.2)	17 (14.2)	9 (7.5)
25) Listen to the teacher explain something to the class as a whole about science.	0	13 (10.8)	43 (35.8)	52 (43.3)	12 (10)
26) Read about science in books, magazines, articles ( <b>not</b> textbooks).	4 (3.3)	60 (50)	48(40)	6 (5)	2 (1.7)
27) Work <i>individually</i> on science assignments.	3 (2.5)	30 (25)	55 (45.8)	24 (20)	8 (6.7)
28) Write about science in a report/paper on science topics.	14 (11.7)	59 (49.2)	32 (26.7)	12 (10)	3 (2.5)
29) Do a laboratory activity, investigation, or experiment	0	1(.8)	28 (23.3)	46 (38.3)	45 (37.5)
30) Watch the teacher demonstrate a scientific phenomenon	4 (3.3)	41 (34.2)	59 (49.2)	12 (10)	4 (3.3)
31) Collect data (other than laboratory activities).	17 (14.2)	48 (40)	33 (27.5)	14 (11.7)	8 (6.7)
32) Work <i>in pairs or small groups</i> (other than laboratory activities)	1 (.8)	11 (9.2)	22 (18.3)	45 (37.5)	41 (34.2)
33) Do a science activity with the class outside the classroom or science laboratory (for example, field trips or research).	45 (37.5)	48 (40)	20 (16.7)	5 (4.2)	2 (1.7)
35) Maintain and reflect on a science portfolio of their own	54 (45)	25 (20.8)	16 (13.3)	14 (11.7)	11 (9.2)
37) Make educated guesses, predictions, or hypotheses.	0	25 (20.8)	50 (41.7)	29 (24.2)	16 (13.3)
38) Follow step-by-step directions.	1 (.8)	20 (16.7)	58 (48.3)	27 (22.5)	14 (11.7)
39) Use science equipment or measuring tools.	0	8 (6.7)	34 (28.3)	37 (30.8)	41 (34.2)
40) Collect data.	0	7 (5.8)	35 (29.2)	36 (30)	42 ( 35)



41) Change a variable in an experiment to test a hypothesis.	2 (1.7)	30 (25)	48 (40)	25 (20.8)	15 (12.5)
42) Organize and display information in tables or graphs.	1 (.8)	20 (16.7)	39 (32.5)	30 (25)	30 (25)
43) Analyze and interpret science data.	1 (.8)	17 (14.2)	27 (22.5)	40 (33.3)	35 (29.2)
44) Design their own investigation or experiment to solve a scientific question.	11(9.2)	44(36.7)	42(35)	13(10.8)	10(8.3)
45) Make observations/classifications.	0	6 (5)	39 (32.5)	40 (33.3)	35 (29.2)
46) Talk about ways to solve science problems, such as Investigations	5 (4.2)	27 (22.5)	54 (45)	26 (21.7)	8 (6.7)
47) Complete written assignments from the textbook or workbook.	19 (15.8)	38 (31.7)	38 (31.7)	21 (17.5)	4 (3.3)
48) Write up results or prepare a presentation from a laboratory activity, investigation, experiment, or research project.	10 (8.3)	34 (28.3)	39 (32.5)	28 (23.3)	9 (7.5)
49) Work on an assignment, report, or project over an extended period of time.	11 (9.2)	44 (36.7)	38 (31.7)	21 (17.5)	6 (5)
51) Review assignments or prepare for a quiz or test.	8 (6.7)	36 (30)	43 (35.8)	24 (20)	9 (7.5)
52) Have a class discussion about the data	3 (2.5)	25 (20.8)	47 (39.2)	30 (25)	15 (12.5)
54) Make a prediction based on the data	1 (0.8)	22 (18.3)	54 (45)	27 (22.5)	16 (13.3)
55) Analyze and interpret the information or data, orally or in writing	1 (0.8)	22 (18.3)	41 (34.2)	33 (27.5)	23 (19.2)
56) Make a presentation to the class on the data, analysis, or interpretation	16 (13.3)	48 (40)	38 (31.7)	15 (3)	3 (2.5)
61) Display and Analyze data (using edu. technology)	4 (3.3)	40 (33.3)	37 (30.8)	22 (18.3)	17 (14.2)

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Table H2

*Teachers Report of Sense of Preparation for Science Instruction*

SEC Item	n (%)			
	Not well prepared	Somewhat prepared	Well prepared	Very well prepared
83) Teach Science at your assigned level	0	5 (4.2)	28 (23.3)	87 (72.5)
84) Integrate science with other subjects	6 (5.0)	30 (25.0)	42 (35.0)	42 (35.0)
85) Provide science instruction that meets science Content standards (district, state, or national)	1 (0.8)	4 (3.3)	39 (32.5)	76 (63.3)
86) Use a variety of assessment strategies (including objective and open-ended formats)	4 (3.3)	16 (13.3)	48 (40.0)	52 (43.3)
87) Manage a class of students who are using hands-on or laboratory activities	4 (3.3)	14 (11.7)	38 (31.7)	64 (53.3)
88) Take into account students' prior conceptions about natural phenomena when planning	2 (1.7)	19 (15.8)	59 (49.2)	40 (33.3)

TableH3

*Teachers Report of School Culture/Climate*

SEC Item	n (%)				
	Strongly disagree	Disagree	Neutral/ Undecided	Agree	Strongly Agree
95) I am supported by colleagues to try out new ideas	2 (1.7)	8 (6.7)	13 (10.8)	47 (39.2)	50 (41.7)
96) I am required to follow rules at this school that conflict with my best professional	30 (25.0)	37 (30.8)	31 (25.8)	14 (11.7)	8 (6.7)

judgment about teaching and learning science

97) Science teachers in this school regularly observe each other teaching classes	39 (32.5)	50 (41.7)	9 (7.5)	19 (15.8)	3 (2.5)
98) Science teachers in this school trust each other	3 (2.5)	13 (10.8)	12 (10.0)	45 (37.5)	47 (39.2)
99) It's OK in this school to discuss feelings, worries, and frustrations with other science teachers.	4 (3.3)	7 (5.8)	18 (15.0)	39 (32.5)	52 (43.3)
100) Science teachers respect other teachers who take the lead in school improvement efforts	1 (0.8)	5 (4.2)	25 (20.8)	51 (42.5)	38 (31.7)
101) It's OK in this school to discuss feelings, worries, and frustrations with the principal	12 (10)	8 (6.7)	23 (19.2)	44 (36.7)	33 (27.5)
102) The principal takes personal interest in the professional development of the teachers	9 (7.5)	13 (10.8)	24 (20.0)	40 (33.3)	34 (28.3)

Table H4

*Teachers Report of Instructional Influences- Policy Related*

SEC Item	n (%)					
	N/A	Strong negative influence	Somewhat negative influence	Little or no influence	Somewhat positive influence	Strong positive influence
71) Your state's curriculum framework or content standards	11 (9.2)	4 (3.3)	8 (6.7)	11 (9.2)	46 (38.3)	40 (33.3)
72) Your district's curriculum framework or	11 (9.2)	3 (2.5)	8 (6.7)	17 (14.2)	45 (37.5)	36 (30.0)

guidelines

74) State tests or results	15 (12.5)	12 (10.0)	11 (9.2)	30 (25.0)	37 (30.8)	15 (12.5)
75) District tests/results	35 (39.2)	3 (2.5)	10 (8.3)	39 (32.5)	26 (21.7)	7 (5.8)
76) National science education standards	1 (0.8)	1 (0.8)	1 (0.8)	28 (23.3)	58 (48.3)	31 (25.8)
81) Parents/Community	4 (3.3)	1 (0.8)	13 (10.8)	58 (48.3)	36 (30.0)	8 (6.7)
82) Preparation of students for the next grade level	2 (1.7)	0	2 (1.7)	20 (16.7)	63 (52.5)	33 (27.5)

Table H5

*Teachers Report of the Quality of Professional Development Activities*

SEC Item	n (%)			
	Never	Rarely	Sometimes	Often
113) Observed demonstrations of teaching techniques	20 (16.7)	38 (31.7)	46 (38.3)	16 (13.3)
114) Led group Discussion	34 (28.3)	38 (31.7)	40 (33.3)	8 (6.7)
115) Developed curricula or lesson plans, which other participants or the activity leader reviewed	26 (21.7)	29 (24.2)	44 (36.7)	21 (17.5)
116) Reviewed student work or scored assessments	11 (9.2)	17 (14.2)	25 (20.8)	67 (55.8)
117) Developed assessments or tasks	8 (6.7)	10 (8.3)	35 (29.2)	67 (55.8)
118) Practiced what you learned and received feedback	14 (11.7)	25 (20.8)	55 (45.8)	26 (21.7)
119) Received coaching or mentoring in the classroom	31 (25.8)	42 (35.0)	36 (30.0)	11 (9.2)
120) Gave a lecture or presentation to colleagues	44 (36.7)	41 (34.2)	28 (23.3)	7 (5.8)
121) Designed to support the school-wide	32 (26.7)	18 (15.0)	46 (38.3)	24 (20.0)

improvement plan adopted by your school				
122) Consistent with your science department or grade level plan to improve teaching	19 (15.8)	24 (20.0)	44 (36.7)	33 (27.5)
123) Consistent with your own goals for your professional development	18 (15.0)	23 (19.2)	48 (40.0)	31 (25.8)
124) Based explicitly on what you had learned in earlier professional development activities	20 (16.7)	30 (25.0)	58 (48.3)	12 (10.0)
125) Followed up with related activities that built upon what you learned as part of the activity	20 (16.7)	27 (22.5)	62 (51.7)	11 (9.2)

Table H6

*Teachers Report of Amount of Science Content Specific Professional Development*

SEC Item	n (%)			
	None	Slight	Moderate	Great
130) State science content standards (for example, what they are and how they are used)	23 (19.2)	40 (33.3)	37 (30.8)	20 (16.7)
131) Alignment of science instruction to curriculum	14 (11.7)	31 (25.8)	43 (35.8)	32 (26.7)
132) Instructional approaches (for example, use of manipulatives)	12 (10.0)	29 (24.2)	50 (41.7)	29 (24.2)
133) In-depth study of science or scientific concepts within science (for example, earth science)	31 (25.8)	37 (30.8)	32 (26.7)	20 (16.7)
134) Study of how children learn particular topics in science	24 (20.0)	42 (35.0)	47 (39.2)	7 (5.8)
135) Individual differences in student learning	17 (14.2)	41 (34.2)	46 (38.3)	16 (13.3)
136) Meeting the learning needs of special populations of students (for example, second language learners; students with disabilities)	29 (24.2)	45 (37.5)	37 (30.8)	9 (7.5)

137) Classroom science assessment (for example, diagnostic approaches, textbook-developed tests, teacher-developed tests)	28 (23.3)	44 (36.7)	38 (31.7)	10 (8.3)
138) State or District science assessment (for example, preparing assessments, understanding assessments, or interpreting assessments)	33 (27.5)	36 (30.0)	34 (28.3)	17 (14.2)
139) Interpretation of assessment data for use in science instruction	32 (26.7)	37 (30.8)	41 (34.2)	10 (8.3)
140) Technology to support student learning in science	20 (16.7)	36 (30.0)	43 (35.8)	21 (17.5)

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## ACADEMIC PREPARATION

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| <b>Ph.D. Science Education</b><br>Syracuse University, Syracuse, NY<br>Dissertation: Reform-based science teaching: A mixed methods approach to explaining variation in secondary science teacher practice<br>Dissertation Chair: John W. Tillotson, Ph.D.<br>GPA: 4.0 | 2014 |
| <b>M.S. Secondary Science Education - Biology Preparation Certification 7-12</b><br>Syracuse University, Syracuse, NY<br>GPA: 4.0  | 2006 |
| <b>M.P.S. Environmental and Forest Biology</b><br>State University of New York College of Environmental Science and Forestry, Syracuse, NY<br>GPA: 4.0   | 2006 |
| <b>B.S. Recreation and Park Management</b><br>Area of Concentration: Environmental Interpretation<br>Pennsylvania State University, State College, PA<br>GPA: 3.9  | 2001 |

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## UNIVERSITY TEACHING EXPERIENCE

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| <i>Syracuse University, Syracuse, NY</i><br><b>Methods and Materials in Teaching the Physical Sciences SCE 737</b> -Teaching Assistant:<br>Assisted with instruction and graded student assignments for a course focused on the use of inquiry-based teaching in the physical sciences.   | Spring 2013      |
| <i>Syracuse University, Syracuse, NY</i><br><b>Methods and Curriculum in Teaching Science SCE 413/613</b> -Teaching Assistant: Assisted with the planning, instruction, and assessment of a methods course for undergraduate and graduate secondary education students. Developed and taught a series of 5 classes related to effective planning for teaching, collaborative learning, and classroom management. Held conferences with individual teachers to provide formative feedback on their planning and instruction. | Spring 2012      |
| <i>Syracuse University, Syracuse, NY</i><br><b>Elementary Science Methods and Curriculum EED 337</b> - Teaching Assistant: Assisted with the planning, instruction, and assessment of a science methods course for undergraduate elementary education majors. Advised students on the development and implementation of their unit plans during their field practicum. Worked collaboratively with other education faculty to identify students in need of support during the course and practicum experiences.             | Fall 2011 & 2012 |
| <i>Syracuse University, Syracuse, NY</i><br><b>Seminar in Science Education Research SCE 789</b> - Teaching Assistant: Assisted with the planning and instruction of a graduate level education course, assessed graduate student work and assigned grades.   | Fall 2006        |

Syracuse University, Syracuse, NY

2005 - 2006

**Science: Questions and Quests -Physical Phenomena I SCI 104 & Questions and Quests-Physical Phenomena II SCI 105** - Instructor: Developed curriculum and instruction for two physical science courses designed for elementary education majors, held office hours, designed assessment tools, and assigned grades.

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## K - 12 TEACHING EXPERIENCE

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**Penn Delco School District Northley Middle School**, Aston, PA

2007 - 2009

*7<sup>th</sup> Grade Science Teacher:* Instructed two sections of honors life science and 3 sections of accelerated life science including a section co-taught with a special education teacher. Collaborated with grade level partner, district science curriculum coordinator, and a university professional development consultant to design authentic assessments for the curriculum. Member of the Student Assistant Team and the Positive Behavior Support Committee and served as the 7<sup>th</sup> and 8<sup>th</sup> grade field hockey team coach.

**Harcum College Upward Bound Program**, Byrn Mawr, PA

Summer 2007

*Science Instructor:* Designed and instructed three science courses (biology, chemistry, and introductory college level science) for 10<sup>th</sup> – 12<sup>th</sup> grade students from the Philadelphia School District taking part in a 6 week academic enrichment program designed to help potential first generation college students overcome educational, cultural, and social barriers of society.

**Southern Cayuga Elementary School**, Sherwood, NY

2002 - 2003

*Substitute Teacher:* Substitute taught for various elementary classrooms

**Moravia Elementary School**, Moravia, NY

2002

*Substitute Teacher:* Substitute taught for various elementary classrooms

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## RELATED PROFESSIONAL EXPERIENCE

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**BSCS (Biological Science Curriculum Study)**, Colorado Springs, CO

2012

*Consultant:* Participated as a field consultant on a NSF-funded project, TWIST (Tying Words to Images of Science Teaching). Collaborated with a national sample of education researchers to field test a new research tool for coding science teaching lessons to assess for coherence in lesson plan design and instruction.

**Syracuse University**, Syracuse, NY

2009-2011

*Research Assistant- NSF IMPACT Grant:* Graduate research assistantship with the IMPACT project (Investigating the Meaningfulness of Preservice Programs Across the Continuum of Teaching). Collaborated with a research team to develop a deeper understanding of secondary science teachers' beliefs and practices. Responsibilities included organization of data, data coding, both qualitative and quantitative data analysis, synthesis of research findings, and dissemination efforts including conference presentations and preparing manuscripts for publication.

**State University of New York College Environmental Science and Forestry**, Syracuse, NY

2004- 2005

*Research Associate:* Designed and implemented a professional development workshop on Lake Ecology for secondary science teachers. Also designed a supplementary science education module, poster, and pocket guide curriculum support materials.

**The Cayuga Nature Center**, Ithaca, NY

2003

*Education Director:* Coordinated all school programs, directed all educational outreach programs, and directed the preschool science program. Hired and supervised all education staff and interns.

**The Cayuga Nature Center, Ithaca, NY**

2002

**PeeWee Program Director:** Managed a grant funded project aimed at developing a traveling natural science program for preschool students. Developed and instructed lessons for natural science outreach program as well as developed and instructed a seasonal preschool science program. Co-wrote a natural science curriculum for preschool age children. Managed details of the grant and drafted grant final report.

**The Natural Resource Trust of Easton, Easton MA**

2001

**Educator/Naturalist:** Instructed environmental education classes for the local public school systems grades K – 6 and served as field trip coordinator.

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**HONORS AND AWARDS**


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All-University Doctoral Prize	Syracuse University, 2014
AERA Institute on Statistical Analysis for Causal Inference Grant Award	Washington, D.C. May, 2013
Outstanding Teaching Assistant Award	Syracuse University, 2012
Future Professoriate Program Fellow	Syracuse University, 2010-2012
Certificate in University Teaching	Syracuse University, 2012
Women in Science and Engineering (WISE) Fellow	Syracuse University, 2010-2011
Member of the Honor Society Phi Kappa Phi	Syracuse University, 2010
School of Education Travel Grant	Syracuse University, 2012, 2013 & 2014
Graduate Student Organization Travel Grant	Syracuse University, 2012, 2013 & 2014
Marvin Druger Department of Science Teaching Travel Grant	Syracuse University, 2011
Edna Bailey Sussman Fellowship	SUNY College of Environmental Science and Forestry, 2006
Ruth W. Ayers-Givens Scholarship	Pennsylvania State University, 2000-2001
Shreyers Honors College Member	Pennsylvania State University, 1999- 2001
National Society of Collegiate Scholars	Pennsylvania State University, 2000
Golden Key Honor Society	Pennsylvania State University, 1999- 2001

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**PEER-REVIEWED PROFESSIONAL PRESENTATIONS**


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**Jetty, L.E.,** Tillotson, J.W., & Young, M. *The Periphery of Teaching: Influence of External Factors on Science Teacher Practice.* Poster presented at the National Association for Research in Science Teaching Annual Meeting, April 2013, Rio Grande, Puerto Rico.

**Jetty, L.E.,** Tillotson, J.W., & Barry, D.S. *Science Teacher Practice in the Classroom: Predicting Reform Based Pedagogy.* Paper presented at the Association for Science Teacher Education Annual Meeting, January 2012. Clearwater, FL, USA.

**Jetty, L.E.**, Tillotson, J.W., Young, M.O., Barry, D.S., & Dolphin, G.R. *Visions of good teaching: Qualitative description of teachers' beliefs*. Paper presented at the Association for Science Teacher Education Annual Meeting, January 2011. Minneapolis, MN, USA.

Young, M.J., Tillotson, J.W., Dolphin, G.R., & **Jetty, L.E.** The impact of critical learning experiences on science teacher development. Paper presented at the National Association for Research in Science Teaching Annual Meeting, March 2010, Philadelphia, PA, USA.

Young, M.J., Tillotson, J.W., Sadehpour-Kramer, M., Dolphin, G.R., & **Jetty, L.E.** Investigating the meaningfulness of preservice programs across the continuum of teaching: The IMPPACT of teacher preparation programs on science teacher beliefs and practices. Paper presented at the Association for Science Teacher Education Annual Meeting, January 2010, Sacramento, CA, USA.

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#### MANUSCRIPTS IN-PROGRESS

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**Jetty, L.E.**, Tillotson, J.W., Young, M.O. Visions of good teaching: Qualitative description of teachers' beliefs. Manuscript in preparation for *Science Education*.

Tillotson, J.W., **Jetty, L.E.**, Young, M.O. External factors and science teaching: Influences on beliefs and practices. Manuscript in preparation for *Journal of Science Teacher Education*.

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#### SERVICE TO EDUCATION COMMUNITY

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Supervisor for Secondary Science Education Preservice Teacher	2011
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Member of Syracuse University Teaching Committee for Promotion & Tenure	2011
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Reviewer- Association for Science Teacher Education Conference Proposals

Reviewer - National Association for Research in Science Teaching Conference Proposals

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#### PROFESSIONAL MEMBERSHIPS

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National Association for Research in Science Teaching (NARST)

Association for Science Teacher Education (ASTE)

American Educational Research Association (AERA)