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AGENCY OF NOVICE PRE-SERVICE SECONDARY SCIENCE TEACHERS AND
THE INFLUENCES ON THEIR PLANNING DECISIONS

A Dissertation
Presented for the
Doctor of Philosophy
Degree
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Andrea Wentworth Henrie
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Dedication

This dissertation is dedicated to my husband, Mr. Darren Henrie, for his constant support.

His encouragement and faith in my abilities has been greater than I have ever received
and will continue to inspire me.

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Abstract

This study examined six novice pre-service secondary science teachers' lesson planning processes when designing instruction while enrolled in a spring education course prior to their student teaching. Six novice pre-service secondary science teachers enrolled in an education course during the spring semester prior to their student teaching. During the course, participants were introduced to the lesson planning software, Tennessee's Next Generation Tools for Teaching Standards-Based Science, version 1.4 (Jordan & Audet, 2007). This software provides resources, sample lesson plans, and links lesson planning with four science reform documents, *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993, p. 4), *Science for All Americans* (American Association for the Advancement of Science, 1990), *National Science Education Standards* (NSES) (National Research Council, 1996), and *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007). Participants used this software to write their first science lesson plans. The focus of this research was to examine the processes novice pre-service teachers pursue as they engage in lesson planning and the sources that influence their planning decisions. Findings are as follows:

- 1) novice pre-service secondary science teachers acknowledged the importance of Standards but planned in a sequence that found lesson activities before objectives; 2) despite similar experiences with a science lesson plan template, students used two different approaches to lesson planning; 3) science education reform documents were consulted by all participants when writing lesson plans, however participants did not find all of the science education reform documents to be beneficial.

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CHAPTER I: INTRODUCTION

Many reports speak to the urgency of helping our students become scientifically literate, such as The National Commission on Mathematics and Science Teaching for the 21st Century (2000; 2000), while other countries are investing heavily to create scientifically and technically literate work forces (Friedman, 2005). To keep pace in global markets, the United States needs to have an equally capable citizenry. Obtaining scientific literacy will enable students to excel in the workplace, to engage intelligently in public discourse, debate about important issues that involve science and technology, and make decisions that will improve the quality of life for future generations. Scientifically literate citizens understand how science affects their communities and lives and use scientific approaches for analyzing and solving problems (Chubin & Kumar, 2000).

A scientifically literate society begins in educational systems committed to science literacy (AAAS, 1989). Plourde and Alawiye (2003), argue that within our educational institutions a “fundamental shift towards student-centered/ constructivist teaching and learning in P-12 classrooms is needed in order to fulfill the responsibility of “producing” members of society who will have the skills required to be effective citizens of the 21st century” (p.338). This shift towards student-centered/ constructivist teaching must take place in K-12 classrooms and can be supported when student-centered/ constructivist strategies are introduced in teacher preparation programs. While research shows a clear need for instructional strategies based on a constructivist model of learning, today’s practice remains rooted in behaviorist theory and rote methods of learning (Zeidler, 2002). A new vision of science teaching and learning must be based on

instruction that emphasizes engaged learning, in which students create meaning from their own experiences. Supporting reform-based science teaching is one of the most important ways to improve our schools and enhance science literacy.

Hiring teachers who are highly qualified and committed to teach science through reform-based teaching strategies is central to obtaining scientific literacy for all Americans. An initiative by the American Association for the Advancement of Science (AAAS), titled Project 2061, was begun in 1985 to give direction to science education reform. Project 2061 makes several recommendations to improve the breadth and depth of teachers' understanding of science, mathematics, and technology, also recommending that colleges and universities use these reports as a guide in designing courses for future elementary and secondary teachers (Collins, 1998; DeBoer, 2002). In *Science for All Americans* (SFAA) (AAAS, 1990), AAAS describes what constitutes adult literacy, recommending what all students should know and be able to do in science, mathematics, and technology by the time they graduate from high school. Subsequent publications such as the *Benchmarks for Science Literacy* (AAAS, 1993), *The Atlas of Science Literacy* (AAAS, 2001), and the *National Science Education Standards*, NSES (National Research Council, NRC, 1996) describe how science content should be presented to students in a developmentally appropriate way, and provide suggestions for pedagogical strategies.

The recommendations for educational reform presented in these documents emphasize that teachers are central to reform, but do not solely hold them responsible for achieving it. According to Brook and Kopp (1989), "if teacher education is to meet its responsibility to prepare teachers for the information age, then teacher educators have a

professional responsibility to provide leadership in developing the full potential of existing and emergent technologies in teacher training” (p. 2). Therefore, informed and determined leadership at every level, including institutions that prepare teachers, is crucial for achieving science education reform.

Statement of a Problem

Lesson plans are introduced in every teacher education program, are used in teacher evaluations, are often examined by principals, and provide insight into a teacher’s practices. In light of No Child Left Behind (NCLB) mandates, the role of teacher as planner has become increasingly important (Reese, 2004; Strangis, Pringle, & Knopf, 2006). Many authors have pointed to the importance of planning because it forms a knowledge base for scaffolding instruction that reflects the essential features of reform based practice (Jimenez & Sanmarti, 1995; Sanchez & Valcarcel, 1999; Strangis, et al., 2006; Tobin & Tippins, 1993). Furthermore, lesson plans play an important role in teacher preparation and teacher evaluations.

Little attention has been given to how pre-service teachers plan for instruction (Samaras, 2000). Strangis, Pringle, and Knopf argue “literature contains few empirical data regarding the development of pre-service teachers’ planning skills during their initial teacher preparation program” (Strangis et al., 2006, p.73). One of the objectives of the research presented here is to answer this call, which is to describe how pre-service science teachers plan for instruction and the processes that influence them as they engage in planning their first science lesson. I argue that investigating and understanding the

processes of lesson planning will provide us with knowledge and insights needed for preparing future secondary science teachers.

Research Questions

The following questions guided my inquiry.

1. What processes do novice pre-service secondary science teachers pursue as they engage in lesson planning?
2. Does novice pre-service secondary science teachers' planning during field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?
3. What sources do novice pre-service secondary science teachers consult in making decisions about planning and which of those sources influence planning decisions?
 - *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)
 - *Science for All Americans* (American Association for the Advancement of Science, 1990)
 - *Tennessee Curriculum Standards* (TN Department of Education 2007)
 - *National Science Education Standards* (National Research Council, 1996)
 - *Tennessee's Next Generation Tools for Teaching Standards-Based Science* (Jordan & Audet, 2007)

Scientific Literacy

The United States needs scientifically literate citizens who will be able to compete in the modern world of science, technology, and mathematics (AAAS, 1990). Advances in these fields determine the success and achievements of our nation (National Academy of Sciences, 2006). In the past decades, U.S. student scores in science and mathematics have not reflected well on the current state of education in America. The classic Third International Mathematics and Science Study (TIMSS, 2003) of students in 41 countries found that high school seniors in the United States showed little general knowledge of science and mathematics in comparison with students from other countries. For the United States to continue to thrive as a society and compete effectively with other countries in the 21st century, our systems of education will have to be more effective in preparing students and teachers in science, mathematics, and technology (National Academy of Sciences, 2006).

Science Teacher Preparation

The Association for Science Teacher Educators (ASTE) states that competent teachers have a direct, positive effect on students' learning (Association of Science Teacher Educators, 2004, p. 1). The United States must attract, prepare, and retain pre-K-16 science teachers who are well educated and possess a conceptual understanding of science (Aydeniz, 2007). These teachers must also have a working knowledge of how people learn science and they must have the ability to create meaningful learning experiences at developmentally appropriate levels for their students (Association of Science Teacher Educators, 2004). Our nation's students are best served by teachers who have acquired the specialized knowledge of teaching and assessment that enable them to

promote science learning (Peterson, 1983). Pre-service teachers are taught how to create these meaningful learning experiences through their initial experiences of linking teaching strategies and content knowledge through lesson planning (Tobin & Tippins, 1993). This work promises to inform discussions surrounding both pre-service teacher education and science education. If we are to truly enact science education reforms, developing a better understanding into pre-service science teachers' conceptions of lesson planning is essential.

Research Design

Overview of the Study

A qualitative methodology guided my inquiry of pre-service teachers' processes when planning instruction. Qualitative research "involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them" (Creswell, 1998, p.3).

A collective case study methodology was chosen for this study. "A case study is an exploration of a "bounded system" or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in context" (Creswell, 1998). The "bounded system" for this research is participation in the TPTE 353 course over a 4-month period. A major strength of case study data collection is the "opportunity to use many different sources of evidence" (Robert K. Yin, 2003). This is a collective case study because multiple cases, or participants' views, were analyzed. Yin also states that any finding or conclusion in a case study is likely to be "much more convincing and accurate if it is based on several different sources of

information” (2003, p.98). Data were collected in this study from multiple sources, using multiple methods, for data triangulation (Yin, 1994) in order to understand the beliefs and practices of these six science pre-service teachers on lesson planning. The evidence from collective case studies is often considered more compelling, and the overall study is therefore regarded as being more robust (Herriott & Firestone, 1983). Primarily, data were drawn from three sources; 1) students’ lesson plans; 2) their guided reflections, 3) semi-structured interviews following the writing of their first lesson plan. Participants were interviewed after they wrote the first draft of their science lesson plan, and then again once they finished the final draft of their science lesson plan. In a process called “member checking” (Stake, 1995) participants examined and approved transcripts of their interviews for accuracy and palatability.

Theoretical Framework

Social cognitive theory guided my inquiry. Bandura’s social cognitive theory accords a central role to cognitive, vicarious, self-regulatory, and self-reflective processes in human adaptation and change (Bandura, 1986). People are viewed as self-organizing, proactive, self-reflecting and self-regulating rather than as reactive organisms shaped only by environmental forces or by inner impulses. From this theoretical perspective, human functioning is viewed as the product of a dynamic interplay of personal, behavioral, and environmental influences. Social cognitive theory is rooted in a view of human agency in which individuals are agents proactively engaged in their own development and can make things happen by their actions.

Social cognitive theory provides an agentic conceptual framework within which to analyze the processes pre-service secondary science teachers pursue when making

decisions about lesson planning. Agency refers to acts done intentionally. Social cognitive theory claims that individuals possess self-beliefs that enable them to exercise a measure of control over their thoughts, feelings, and actions. That is, “what people think, believe, and feel affects how they behave” (Bandura, 1986, p.25). Bandura argues that the core features of human agency enable people to play a part in their self-development, adaptation, and self-renewal with changing times. Among the characteristics of personal agency, none is more central or pervasive than people’s beliefs in their capability to exercise some measure of control over their own functioning and over environmental events (Bandura, 1997).

In many spheres of functioning, people do not have direct control over the social conditions and institutional practices that affect their everyday lives. In teacher preparation programs, novice pre-service secondary science teachers do not have control over the educational policies governing today’s system of education, nor do pre-service teachers determine the recommendations proposed through science education reform. However, they do choose when and if they will implement aspects of reform and whether or not they will view science education reform documents as influential in their planning process.

Personal agency operates within a broad network of “sociostructural influences” (Bandura, 2001, p.14) such as the influences imposed on pre-service science teachers by science education reform. Examples of rules in the system of education are academic science standards such as the NSES and Tennessee Science Curriculum Standards. Within the rule structure of social systems, there is a lot of variation in the way people interpret, enforce, adopt, and oppose rules (Bandura, 2001). In the agentic transactions of

pre-service teachers and science teacher preparation programs, pre-service science teachers are producers as well as products of science education reform. Pre-service science teachers can choose to behave accommodatingly to the recommendations of science education reform or, through the exercise of “self-direction” (Bandura, 2001, p.7), to behave otherwise.

Through agentic action, “people figure out ways to circumvent physical and environmental constraints, redesign and construct environments to their liking” (Bandura, 2001, p.22) and create styles of behavior that enable them to realize desired outcomes. The selection of social cognitive theory to understand the processes and influences of pre-service secondary science teachers’ lesson planning is appropriate given that I am using teachers’ views and lesson planning processes to reflect on ways in which lesson planning may be introduced into science education programs.

Instructional Context

The participants are students in a graduate level course in education titled TPTE 353: Community-Based Field Experiences Seminar for Middle and Secondary Science, offered at a state flagship university in the southeastern United States. This course enrolled students who held degrees in Biology, Physics, or Chemistry. Pre-service teachers took this course as an initial licensure requirement. The course was offered during the spring semester prior to the year long internship beginning in the fall. In the spring of 2007, new technologies were used in TPTE 353 to help pre-service science teachers with the culturally responsive science lesson plans they would design for their field placements, Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Audet & Jordan, 2003).

Dr. Richard Audet of the Roger Williams University School of Education and Linda Jordan, Tennessee Department of Education State Science Coordinator, write that to be successful in a standards-based educational system, every science educator must have access to creative and labor-saving technologies such as the curriculum development, assessment, and instructional tools and techniques found on *Tennessee's Next Generation Tools for Teaching Standards-Based Science CD*, version 1.4 (Audet & Jordan, 2003b; Dalton, 2006; Jordan & Audet, 2007). In the 2007 Spring TPTE 353 course, templates and procedures found in the *Next Generation Tools for Standards-Based Science Teaching CD* were used as a primary resource to introduce novice pre-service science teachers to lesson planning and to enable them to develop classroom learning experiences that are grounded in the Tennessee standards, emphasize learning through guided inquiry using the 5E learning cycle model (Trowbridge, Bybee, & Powell, 2004b), and target higher order thinking skills (Tennessee Science Teacher Association, 2006).

The tools and techniques found on the CD hold potential to facilitate the delivery of dynamic and exciting standards-based science teaching and enhance the learning capabilities of students. The resources are “intuitive, customizable, and directly aimed at helping science educators to hone their skills and flourish” in today’s educational environment (Dalton, 2006). The CD resources emphasize the importance of curriculum integration and make extensive use of the Internet through the development of Web Quest lessons.

The CD and its accompanying guide *Standards in the Classroom: An Implementation Guide for Teachers of Science and Mathematics (Guide)* (Audet &

Jordan, 2003b) were created after the call for educational standards (National Research Council, 1996) had subsided, but just as the uproar over federal and state mandated testing was reaching a high (Audet & Jordan, 2003b, p. xv). During this time it became evident to Audet and Jordan that “few effective and teacher-friendly professional development models and mechanisms existed for helping educators implement standards-based curriculum and instruction in their classrooms” (Audet & Jordan, 2003b). The Guide and CD were written to cover the full range of issues and topics that are relevant for implementing content standards in the classroom. For this reason, the guide and CD were chosen for the TPTE 353 course. The Guide and CD focus on the following points:

- Recognizing and addressing principles of teacher change
- Employing a constructivist approach to teaching and learning
- Understanding the standards-based reform movement
- Using national standards resources to better understand state and local standards
- Developing performance-based assessments linked to standards
- Using standards to guide lesson planning, instruction, and the selection of curriculum materials
- Analyzing a curriculum through principles embedded in the Guide
- Applying curriculum mapping to align a curriculum with standards (Audet & Jordan, 2003b).

The Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Audet & Jordan, 2003) employs use of the 5E instructional model of lesson planning. In the early 1960s, J. Myron Atkin and Robert Karplus (Atkin & Karplus, 1986) proposed a cycle of learning based on the psychological theories of Piaget. This learning cycle was used in organizing lessons in Science Curriculum Improvement Study (SCIS) materials (Trowbridge, Bybee, Powell, 2004b). Trowbridge, Bybee, and Powell (2004b) elaborated on the original design by Atkin and Karplus to create the 5E model. The 5E instructional model is based on a constructivist view and has five phases: engagement, exploration, explanation, elaboration, and evaluation. Due to its use of inquiry processes, it was chosen for this science-specific software.

Assumptions of the Study

The following assumptions underlie the study:

1. The pre-service secondary science teachers selected for this study had not experienced standards-based science lesson planning prior to the TPTE 353 course and therefore could benefit from standards-based science lesson planning.
2. The pre-service secondary science teachers would be able to develop a standards-based science lesson plan as a result of taking the course.
3. Participants provided accurate, honest responses to interviews and guided reflections.
4. Differences in timing of interviews did not influence participants' beliefs.
5. The data sources were coded without bias.

Limitations of the Study

The following limitations underlie the study:

1. Of the twelve, participants were limited to six novice pre-service secondary science teachers in one class at the University of Tennessee.
2. None of the participants had experience with writing science lesson plans in a CD format.

Importance of the Study

Several areas in which the current research base in standards-based lesson planning is lacking include 1) the use of science reform documents in teacher preparation programs, 2) pre-service teachers' initial response to lesson planning, 3) pre-service secondary science teachers' knowledge and views about the goals and purposes of standards-based lesson planning, and 4) research regarding pre-service teachers' use of Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007). This study addresses each of these issues.

The participants were enrolled in an initial licensure program. Each of the novice pre-service secondary science teachers had obtained a previous degree in biology or physics. TPTE 353 was designed to provide the participants opportunities to 1) collaborate with each other as well as with students in an urban community field placement, 2) be introduced to science lesson planning software, 3) be introduced to science reform documents, and 4) develop understandings about the urban community and student development through their field placement. This study elicited

participants views on science reform documents, the process of lesson planning, and use of Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007).

Definition of Key Terms

5E Model – an instructional model based on a constructivist view and has five phases: engagement, exploration, explanation, elaboration, and evaluation (Trowbridge, Bybee, & Powell, 2004)

Agency – “people’s beliefs in the capability to exercise some measure of control over their own functioning and over environmental events” (Bandura, 2001, p.10)

Benchmarks for Science Literacy – a document that specifies how students should progress toward science literacy by outlining learning goals to be targeted at certain grade levels.

Community Field Placement – a field placement in which pre-service teachers are purposefully placed with a community agency to provide familiarity with urban children, communities, and situations outside the school environment.

Constructivism – “the contemporary view of learning (in which) people construct new knowledge and understandings based on what they already know and believe” (NRC, 2000, p. 10)

CD – Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007)

National Science Education Standards (NSES) – a document published by the National Research Council that provides a rich description of appropriate reform in science education

Novice Pre-service Secondary Science Teacher (NPSST) – a student within a teacher preparation program who is just beginning initial licensure in grades 7-12 education coursework

Professional Development – “All of the activities in which teachers engage to increase, refine, and update their skills” (Austin, Roehrig, Luft, Fife, & Potter, 2003, p. 4)

Rubric – a set of definitions of levels of students performance that are prepared in advance and designed for evaluating students’ work, progress, participation, and achievements

Science for All Americans (SFAA) – a document that defines science literacy and lays out some principles for effective learning and teaching of science (AAAS, 1989)

Scientific inquiry – “the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (NRC, 1996, p. 23)

Self-Influence – when human agents “operate generatively and proactively, not just reactively, to shape the character of their social systems” (Bandura, 2001, p.15)

Sociostructural Influence – “represent authorized systems of rules, social practices, and sanctions designed to regulate human affairs. These sociostructural functions are carried out by human beings occupying authorized roles” (Bandura, 2001, p.14)

Standards – serve as the basis of educational reform across the nation as educators and policy makers respond to the call for a clear definition of desired outcomes of schooling and a way to measure student success in terms of these outcomes (NRC, 2001). In my study, Standards specifically refer to standards of science education reform found in *NSES* (NRC, 1996), *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007), *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), and *Science for All Americans* (AAAS, 1989).

Tennessee Curriculum Standards – statewide educational Standards for teaching and learning in every content area. In this study, Tennessee Curriculum Standards refers specifically to the science Standards in Tennessee.

TPTE 353 – a science education course provided at the University of Tennessee. This course is only offered to pre-service secondary science teachers.

Urban Schools – schools located within an inner-city with high numbers of minority and low income students. They often suffer from high teacher attrition rates and high teacher and student mobility rates (transfer to the other schools)

Organization of the Study

This dissertation includes five chapters.

Chapter One provides the introduction to the study, statement of the problem, statement of the purpose, research design of the study, assumptions of the study, limitations of the study, importance of the study, and definitions of key terms. Also included in Chapter One are the background, population, research questions, and methods and procedures.

Chapter Two contains a review of the literature and is reported in two sections. The sections are: science teacher preparation, and lesson planning.

Chapter Three describes the collective case study research design used for this study. It contains sections on the rationale for using a collective case study approach, TPTE 353 course background, identification of cases, research question and data source alignment, and how the data were analyzed.

Chapter Four reports the study's findings and is reported in three sections. The first section includes within-case analysis of the four research questions. Section two presents a cross-case analysis of the six novice pre-service secondary science teachers arranged by the four research questions and a presentation of themes developed from the interview responses and guided reflections. Section three presents key findings of the within-case and cross-case analyses.

Chapter Five reports conclusions, discussions, and implications for further research based upon this study's findings.

CHAPTER II: LITERATURE REVIEW

I start this chapter by introducing science teacher preparation standards supported by the National Research Council (NRC, 1996) and the American Association for the Advancement of Science (AAAS, 1989, 1993). Then, I discuss how templates and recommendations for writing lesson plans have emerged during subsequent centuries. In my discussion, I focus on exploring teachers' beliefs toward science education reform and lesson planning.

Science Teacher Preparation

Science Teacher Preparation Standards

The National Science Teachers Association (NSTA) considers strong, performance-based science teacher education programs and science teacher licensure standards to be essential for all science teachers (National Science Teachers Association, 2006). To prepare effective teachers, NSTA recommends that all science teacher preparation programs have a curriculum that includes the following experiences for prospective teachers:

- Develop robust science knowledge and skills beyond the depth and breadth needed for teaching a curriculum based on the (NSES) at the grade levels they are preparing to teach.
- Teach science effectively and appropriately based on the cognitive development of students.

- Construct science concepts with understanding and reflect on the history and nature of science, including the development of major concepts, theories, assumptions, and tenets of scientific practice.
- Create a learning environment that encourages inquiry, which includes the questioning and evaluating of evidence, justifying assertions scientifically, and reflecting on the prospective teachers' assumptions and practices.
- Engage in meaningful laboratory and simulation activities using contemporary technology tools and experience other science teaching strategies with faculty who model effective teaching practices consistent with those expected of the prospective teachers.
- Understand science-specific pedagogical knowledge grounded in contemporary scholarship and school environments.
- Implement their teaching plans, assess and reflect on the learning outcomes, and adjust their teaching to enhance their students' understanding.
- Engage in data-based decision making regarding their teaching behaviors, strategies, and the selection of topics, activities, and materials.
- Develop dispositions for effective science teaching, including a sense of responsibility to students and the community and dedication to the need to grow continually, in part through active involvement in the larger science education community. (National Science Teachers Association [NSTA], 2006)

These science teacher education preparation standards set forth by NSTA are broad statements that give teacher education programs room to create unique learning

opportunities while adhering to central objectives. NSTA teaching standards further divide science teaching into separate components that are most closely associated with science teaching and exemplify the vision of science education described in reform documents (American Association for the Advancement of Science, 1990, 1993). The teaching standards begin with a focus on the planning that teachers do. The NSES also place importance on teaching planning. NSES Teaching Standard A states that all teachers of science should be able to “develop yearlong and short-term goals for students, select science content and adapt and design curricula to meet the interests, knowledge, understanding, abilities and experiences of students, and select teaching and assessment strategies that support the development of student understanding” (NRC, 1996). Additionally, NSES Teaching Standard B (NRC, 1996) requires that science teachers guide and facilitate learning. A challenge to science teacher preparation programs is to meet each of the standards set forth in the NSES (NRC, 1996). Many of the standards set forth by NSES and AAAS documents (AAAS1990, 1993) address issues of student-centered/ constructivist teaching and learning in science. Student-centered constructivist classrooms guide and facilitate learning as the NSES recommend. Following these Standards, science education reformed-based teacher preparation programs prepare pre-service science teachers to create constructivist classrooms.

Constructivist Classrooms

Plourde and Alawiye (2003), argue that a “fundamental shift towards student-centered/ constructivist teaching and learning in P-12 classrooms is needed in order to fulfill the responsibility of “producing” members of society who will have the skills

required to be effective citizens of the 21st century” (p.338). Constructivism reduced to its most basic elements is simply a learning or meaning-making theory. This theory proposes that people create their own understanding, combining what they already believe to be true with new experiences with which they are confronted (Richardson, 1997). As the knowledge base of teaching and learning has grown, ideas of constructivism have matured beyond the individual developmental levels of children to the recognition that knowledge develops in a social setting (Plourde & Alawiye, 2003).

Shymansky, Yore, Trengust, Thiele, Harrison, Waldrip, Stocklmayer, & Venville (1997) describe the manifestation of this as “classrooms in which teachers orchestrate experience and discourse opportunities and social context to produce cognitive conflict in students who progressively resolve these problems by integrating new knowledge into prior knowledge structures” (p.572). That is, both cultural and social settings influence cognitive development, thus the meaning-making end product. Still, some teachers resist constructivist pedagogy (Plourde & Alawiye, 2003). Plourde & Alawiye (2003) argue that this resistance results in constructivist methods courses that do not match what occurs in P-12 classrooms or existing college courses. This makes it easier to understand why there are a limited number of constructivist classrooms in the elementary and secondary setting. Pre-service teachers are being asked to design their teaching based on a pedagogy with which they themselves were never taught.

Teacher preparation programs can close this gap between science education reform expectations and pre-service teachers’ lack of experience with constructivist practices. Stalheim & Scharmann (1996), and Stoddart, Connell, Stofflett, & Peck (1993) propose that the use of constructivist pedagogy and learning cycles could improve the

learning of science among pre-service teachers. Tobin & Tippins (1993) state that constructivist epistemology is useful in the training of pre-service teachers if it is “used as a referent; that is, as a way to make sense of what they see, think, and do” (p.87). This can be done by applying a constructivist epistemology to lesson planning during teacher preparation programs. Plourde & Alawiye (2003) conclude that science courses taught with the needs of pre-service teachers and the learning styles of their prospective future students in mind appear to be relatively more productive than traditionally taught courses.

Numerous design principles are necessary when developing a constructivist teacher preparation program (Barman, 1997; Hammrich, 1998; Richardson, 1997). These include, but are not limited to:

- Use student ideas and questions to guide lessons and instruction;
- Promote collaboration, seeking of information and taking action as a result of the learning process;
- Use the thinking, experiences, and interests of students to drive the lesson;
- Encourage students to test their own ideas;
- Encourage and support the collection of real evidence to support the ideas and reformation of ideas in light of new evidence or experiences.

With constructivist principles such as these in place, teacher preparation programs are more likely to familiarize pre-service teachers with the tenets and benefits of constructivism. It is interesting to note the similarity between constructivist and inquiry practices in the classroom. Both are advocated by science education reform documents. Inquiry is the most crucial argument of NSES (NRC, 1996).

Inquiry

Inquiry has had a role in science education for less than a century (Bybee & Deboer, 1993), but has been embraced by all science reform documents (AAAS, 1990; 1993; NRC, 1996). Before 1900, science was viewed as a body of knowledge that students were to obtain through lecture. John Dewey criticized this approach of direct instruction contending that it does not address science as a process or state of mind. Science is more than a body of knowledge to be learned, there is a method to teach and learn as well (Dewey, 1910). The educator Joseph Schwab (Schwab, 1960, 1966) influenced the establishment of inquiry as a way of introducing students to science concepts. He argued that evidence should build to explanations and the refinement of explanations. That is, students should work in the laboratory before being introduced to formal explanations of science concepts (Schwab, 1960).

The work of Schwab and Dewey, and others including Bruner and Piaget in the 1950s and 1960s, influenced the development of curriculum materials in those decades and into the early 1970s. Although reform of the science curriculum began in the late 1950s, Russia's launching of Sputnik I in 1957, beginning the "space race", became the symbol for a major reform in science education and further spurred the development of curriculum materials that would include inquiry experiences (Trowbridge, Bybee, & Powell2004a).

Throughout the country, in the years to come, awareness of these materials prompted teachers to provide students with more "hands-on" experiences and to involve students in doing rather than being told or only reading about science (NRC, 2000). The

educational implications of current conceptions about scientific inquiry are reflected in reform documents such as the NSES where inquiry is defined as

A set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories (NRC, 1996, p.19).

The standards summarize the elements of scientific inquiry and take inquiry beyond “science as a process”. The new vision includes the “process of science” and requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking skills to develop their understanding of science. The science standards at all levels include both the abilities necessary to do and understand scientific inquiry, and urge that students should learn science in a way that reflects how science actually works (NRC, 1996).

According to the National Research Council, Standard A states that science students must have the abilities and understandings necessary to do scientific inquiry. The standards explicitly state that small groups of students should hypothesize from prior experiences, construct and evaluate explanations, design investigations, conduct experiments, gather and analyze data, conduct peer reviews, communicate arguments, and reflect on the inquiry process. These are the abilities and understandings suggested in the NSES. Additional reform documents point to the importance of inquiry as well.

Benchmarks for Science Literacy (AAAS, 1993) also describe inquiry, stating that students who participate in authentic inquiry investigations have a more accurate

understanding of inquiry in real science. The *Benchmarks* state students should be involved in exploring phenomena as early as kindergarten followed by more advanced experiences through the higher grades. Their involvement should include hypothesizing, investigating, data collecting, data manipulating and presenting (AAAS, 1993). The *Benchmarks* also affirm the notion that every science classroom should involve students in at least one true inquiry investigation, where the student poses the question, designs the investigation, estimates appropriate time, chooses appropriate instruments, conducts trial runs, reports the conclusions to peers and responds to criticism. Reform initiatives state that if students participate in “progressively appropriate good science, the picture they come away with, will likely be reasonably accurate” (AAAS, 1993, p.9). That is, inquiry investigations provide students with an accurate understanding of science.

At the state level, some states have incorporated inquiry into their teacher preparation standards. For example, Tennessee Teacher Licensure Standards (Tennessee Department of Education, 2007) state that the pre-service teacher must have the knowledge and skills to accomplish the following: “demonstrate processes of science such as posing questions, observing, investigating phenomena, interpreting findings, communicating results and making judgments based on evidence and design” and “conduct inquiry-based, open-ended investigations” (Tennessee Department of Education, 2007, p. 8-1). Standards for teaching inquiry-based science create a shift toward student-centered/ constructivist teaching and learning. In order for pre-service science teachers to create a learning environment that incorporates inquiry, they must first be exposed to this pedagogy.

Inquiry in Pre-service Teacher Education

The NSES (NRC, 1996) suggest that experiences engaging in science inquiry enable pre-service science teachers to both learn important science concepts and become familiar with ways of formulating questions, rules of evidence and ways of proposing explanations. The literature indicates that such experiences can have a powerful influence on prospective teachers' developing understanding of science learning and teaching (Dana et. al, 2000, Smith and Anderson 1999, Zembal-Saul and Oliver, 1998).

Haefner & Zembal-Saul (2004) studied a course designed specifically for prospective elementary teachers by a collaborative team of university professors from the Entomology and Science Education departments. The context was carefully structured to support the prospective elementary teachers' developing understandings about instructional practices for the purpose of supporting elementary children's scientific inquiry. As part of the course, the eleven prospective elementary teachers worked in small groups to design and conduct extended science investigations based on questions they developed at the beginning of the course. Findings from this study suggest that engaging in extended inquiry investigations supports the development of more appropriate understandings of science and science inquiry, and that prospective elementary teachers became more accepting of approaches to teaching science that encourage children's questions about science concepts (Haefner & Zembal-Saul, 2004). Moreover, pre-service science teachers should be given opportunities to experience, observe, and absorb the planning and instructional strategies set forth in science reform documents (AAAS, 1989; 1990; NRC, 1996). TPTE 353 provided novice pre-service teachers with the opportunity to examine these science education reform documents to

better understand reform practices such as inquiry and the theory of constructivism with the goal that these concepts would be incorporated into lesson plan decision-making.

Lesson Planning

In colleges and universities across the country, prospective and practicing teachers and administrators take courses on lesson planning, curriculum planning, and instructional planning. Lesson planning receives considerable attention in teacher education programs. Teachers and classrooms rarely function effectively without some kind of planning. Teacher planning has been documented as a significant area in which teachers make a wide variety of decisions (C. Clark & Peterson, 1986). The lesson plan has been an essential tool for teachers since its formulation in the 19th century and educators have proposed several models for designing lessons.

Lesson Plan Models

Objectives-First Model

The objectives-first or rational model was first proposed by Tyler (1950), and is referred to as the Tylerian model. The objectives-first model of curriculum planning consists of a sequence of four steps that expects planners to: (1) formulate objectives, (2) select learning activities, (3) organize learning activities, and (4) specify evaluation procedures (Sardo-Brown, 1988). Yinger (1980) describes this model basically as “a linear ends-means model in which planning progresses logically from one’s goals” (p.108). That is, Tyler’s model is used as a rational scientific method for orderly, careful, curriculum planning.

Research has shown that instead of following the objectives first-model, teachers select conveniently from available sources, such as teacher's editions of textbooks or curriculum guides, those activities that they believe will engage student attention (McCutcheon, 1980). Teachers rehearse plans mentally to anticipate problems and student misconceptions or to elaborate on initial ideas (McCutcheon, 1980; Morine, 1976; Yinger, 1980). Sardo-Brown (1988) argues that teachers may consider the steps of the rational model at some point during planning, but do not use the objectives first approach. In a study of 17 kindergarten teachers, McLeod (1981) found that teachers also attached importance to behavioral objectives, though not at the starting point for planning.

Integrated Ends-Mean Model

An alternative to the Tylerian model is the "integrated ends-mean model" (Zahorik, 1975) proposed by Macdonald (1965) and Eisner (1967). They believe that teachers do not begin their planning by thinking about objectives and then proceeding through Tyler's next 3 stages. Instead, MacDonald and Eisner suggest that a teacher's first lesson planning decision focuses on choosing an activity. Objectives arise and exist only in the setting of an activity, as students choose their own learning, thus pursuing their own objectives. Thus, in MacDonald and Eisner's model "ends for learning become integrated with means for learning, and the specification of goals before an activity becomes meaningless" (Yinger, 1980, p.108). That is, goals for learning are established by students, not teachers, once students have been introduced to the learning activity presented by the teacher. This model of setting goals eliminates the need to set learning

goals or performance objectives prior to instruction. Although Macdonald's prescription is less well known than Tyler's, his model may well be descriptive of what teachers actually do (Zahorik, 1975).

Instructional Theory into Practice (ITIP)

One of the most popular educational models to emerge from the 1970s was Madeline Hunter's Instructional Theory into Practice (ITIP) (Stallings, Robbins, Presbery, & Scott, 1986). Hunter's ideas were accepted and implemented across the United States and received varying reviews. Today, her name is less prevalent in teacher education programs, however her ideas are still taught. Known by several names (A Clinical Theory of Instruction, ITIP, Mastery Teaching, PET, Clinical Teaching, Target Teaching, the UCLA model, the Hunter model) this is a model that Hunter claims "increases the probability of learning by identifying professional decisions teachers must make; supplying research-based cause-effect relationships to support those decisions; and encouraging the teacher to use data emerging from students and classroom situations to augment or correct those decisions" (Hunter, 1985). Learner behavior is also a focus: what students will do to learn and to let the teacher know they have learned (Hunter, 1986).

Hunter based her clinical theory on the premise that the teacher is a decision maker. In his/her classroom, the teacher observes what affects student learning and knows which conditions in content, student, teacher, and situation indicate that modifications are necessary. Seven instructional concepts and skills (The Blocks) are the base of Hunter's Lesson Design: mental set, sharing objectives and purposes,

input/information, modeling/demonstration, checking for understanding, practice: guided and independent, and closure/ extension (Hunter, 2005). Hunter's model is based on psychological theory, primarily behaviorism, and educational research.

In 1982, a study was conducted in two schools implementing Hunter's model of lesson planning (Stallings & Krasavage, 1986). The program was funded to improve the reading and mathematics achievement of Chapter I-eligible children. The intent was to develop training systems aimed at improving classroom instruction. The NAPA project was described as utilizing instruction based on the Hunter model (Stallings et al., 1986). Results of the first year of implementation (Stallings, 1985) and of the second year (Stallings et al., 1986) claimed that the ITIP model produced gains in achievement and time-on-task. On the basis of these reports, Madeline Hunter cited the NAPA study as a validation of her approach. However, a report of the final year's data indicated a drop in implementation and in both time-on-task and achievement (Stallings & Krasavage, 1986). Hunter claims the project did not use the Hunter model but the Long Beach adaptation of her model during the final year of the study (Hunter, 1986).

5 E Model

In the early 1960s, J. Myron Atkin and Robert Karplus (Atkin & Karplus, 1986) proposed a cycle of learning based on the psychological theories of Piaget. This learning cycle was used in organizing lessons in Science Curriculum Improvement Study (SCIS) materials (Trowbridge, Bybee, Powell, 2004b). Trowbridge, Bybee, and Powell (2004b) elaborated on the original design by Atkin and Karplus to form the 5E model.

The 5E instructional model is based on a constructivist view and has five phases: engagement, exploration, explanation, elaboration, and evaluation. Appendix A (Audet & Jordan, 2003a) illustrates the essential features of the learning cycle. In the first phase, a teacher is to engage students in the learning task. This can be done in many ways such as asking a question, defining a problem, or showing a discrepant event. Next, students need to be provided the opportunity to explore their ideas and interests. The aim of this phase is to establish common experiences that a teacher can use later to introduce a concept, process or skill. The third phase is explanation. This phase continues the process of cognitive construction. The teacher directs attention to aspects of the first two phases and provides scientific words for explanations. The fourth phase of the 5E model is elaboration. Once students begin developing an explanation of new concepts, it is important to provide further time and experiences that contribute to learning. Finally, students should receive feedback on their performance. The final phase of the 5E model is evaluation. Here teachers administer test or performance activities to determine each student's understanding and provide each of them with feedback. This model is aligned with many processes involved in scientific inquiry (Audet & Jordan, 2003b), and is the model introduced to pre-service secondary science teachers enrolled in TPTE 353. This model is introduced to pre-service teachers via Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007).

Tennessee's Next Generation Tools for Teaching Standards-Based Science CD

Dr. Richard Audet of the Roger Williams University School of Education and Linda Jordan, Tennessee Department of Education State science coordinator, have

indicated that to be successful in a standards-based educational system, every science educator must have access to creative and labor-saving technologies. They designed the curriculum development, assessment, and instructional tools and techniques found on *Tennessee's Next Generation Tools for Teaching Standards-Based Science CD*, version 1.4 (Audet & Jordan, 2003b; Dalton, 2006; Jordan & Audet, 2007). In the 2007 Spring TPTE 353 course, templates and procedures found in the *Next Generation Tools for Standards-Based Science Teaching CD* were used as a primary resource to introduce inexperienced pre-service science teachers to lesson planning and to enable them to develop classroom learning experiences that are grounded in the Tennessee Curriculum Standards (Tennessee Department of Education, 2007), emphasize learning through guided inquiry using the 5E learning cycle model (Trowbridge et al., 2004b), and target higher order thinking skills (Tennessee Science Teacher Association, 2006).

The tools and techniques found on the CD hold potential to facilitate the delivery of dynamic and exciting standards-based science teaching and enhance the learning capabilities of students (Audet & Jordan, 2003). The resources are “intuitive, customizable, and directly aimed at helping science educators to hone their skills and flourish” in today’s educational environment (Dalton, 2006, p. 3). The CD resources emphasize the importance of curriculum integration and make extensive use of the Internet through the development of Web Quest lessons.

The CD and its accompanying guide *Standards in the Classroom: An Implementation Guide for Teachers of Science and Mathematics (Guide)* (Audet & Jordan, 2003b) were created after the NSES were written and state mandated testing was reaching a high (Audet & Jordan, 2003). During this time it became evident to Audet and

Jordan (2003) that “few effective and teacher-friendly professional development models and mechanisms existed for helping educators implement standards-based curriculum and instruction in their classrooms” (p.xv). The Guide and CD were written to cover the full range of issues and topics that are relevant for implementing content standards in the classroom. For this reason, the guide and CD were chosen to be used in the TPTE 353 course. The Guide and CD focus on the following points:

- Recognizing and addressing principles of teacher change
- Employing a constructivist approach to teaching and learning
- Understanding the standards-based reform movement
- Using national standards resources to better understand state and local standards
- Developing performance-based assessments linked to standards
- Using standards to guide lesson planning, instruction, and the selection of curriculum materials
- Analyzing a curriculum through principles embedded in the Guide
- Applying curriculum mapping to align a curriculum with standards (Audet & Jordan, 2003b).

The Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Audet & Jordan, 2003) also employs use of the 5E instructional model of lesson planning.

Studies of Lesson Planning

Many studies have been conducted on in-service teachers' use of lesson planning. However, empirical data is lacking on pre-service teachers' lesson planning practices (Samaras, 2000; Tobin & Tippins, 1993). Moreover, the studies that are conducted on pre-service teachers typically study elementary teachers. Research is especially lacking on novice pre-service secondary science teachers' use and beliefs about lesson planning. The following studies on lesson planning are meant to be not exhaustive but illustrative.

Study One

Zahorik (1970) did the first empirical study of classroom behavior. He provided six teachers with a partial lesson including behavioral objectives and a detailed outline of content to be covered in a two-week period. He asked six other teachers to reserve an hour of instructional time to carry out a task for the researchers, not giving any further details. Then, just before the appointed time, the teachers were asked to teach a lesson on a specific math concept.

Zahorik (1970) analyzed the lessons taught by participating teachers, focusing on teacher behavior that is sensitive to students. Sensitive behavior toward students was defined as "verbal acts of the teacher that permit, encourage, and develop pupils' ideas, thoughts, and actions" (Yinger, 1980). After noting that teachers who planned showed a less than authentic use of pupils' ideas while teaching, he concluded that the planning model consisting of Tyler's four stages makes teachers less sensitive to pupils.

Study Two

Taylor (1970) conducted a study of teacher planning in British secondary schools. British secondary schools consist of students in grades comparable to U.S. middle schools. He held group discussions with secondary teachers, analyzed course syllabi, and administered a questionnaire to English, science, and geography instructors (n=261). The results indicated that when planning, the teachers first tended to consider facets such as materials and resources, then pupils' interests and aims, and finally evaluation. Taylor did not find that teachers began their planning with purposes and objectives, nor did he find that teachers then moved to planning learning activities necessary to achieve the objectives, as suggested by the objectives-first model. Taylor (1970) found that the teachers in his study began their planning by considering the materials and resources, then student interest and pupil involvement, and finally the role of the teacher. Interestingly, procedures for evaluation and assessment appeared relatively unimportant to the participants in this study.

Study Three

Zahorik continued examining lesson planning (Zahorik, 1975). He conducted a study of 194 teachers and asked them to write a list of the decisions they made before teaching and to indicate the order in which the decisions were made. The decision listed most frequently by teachers (listed by 81%) related to choosing activities for lesson plans. The most frequent decision that teachers said they made first (listed by 52% of the teachers) had to do with content. Only 28% mentioned behavioral objectives as a consideration in their first decision. Zahorik also concluded that the "integrated ends-

means” model proposed by MacDonald (1965) and Eisner (1967) is not a realistic model because only 32% of his participants said that they began their planning by making decisions about activities (Zahorik, 1975).

Study Four

Peterson, Marx, and Clark (Peterson, Marx, & Clark 1978) conducted research focusing on teachers’ decision-making in actual planning situations. They examined 12 teachers’ planning in a laboratory situation, as they prepared to teach a unit to junior high school students with whom the teachers had had no previous contact. During planning periods, teachers participated in “think alouds”. Verbal statements obtained from the “think alouds” were later classified into four categories: objectives, materials, subject matter, and process. The study resulted in three findings: (1) Teachers spent the largest portion of their planning time on content (subject matter) to be taught, (2) Following subject matter, teacher concentrated their planning on strategies and activities, (3) The smallest portion of planning time was spent on objectives. All three findings were consistent with those reported by Zahorik (1975).

Study Five

A study by Morine (1976) also yielded results similar to those found by Peterson, Marx, and Clark. In a semi-controlled classroom setting, Morine collected written plans for two lessons (one in reading and one in math). The researchers analyzed the plans focusing attention on six elements: degree of specificity of the plans, general lesson plan format, statement of goals, attention to pupils’ background and preparation, identification of assessment procedures, and indication of alternative activities. Morine found that the

teachers' plans were fairly specific, used outline form, and paid little attention to behavior goals, student diagnosis, assessment procedures, and alternative courses of action.

Study Six

In 1980, Yinger conducted a study to both provide a description of one teacher's planning and to formulate a general model of the teacher planning process (Yinger, 1980). The "process model" of planning resulted from this study, focusing on the "individual, proactive, deliberate information-processing involved in planning, from an initial idea to its execution in the classroom" (Yinger, 1980). In Yinger's process model, teachers approach planning as a three-stage problem-solving task: (1) content, goals, knowledge, and experience combine to yield an initial conception of an activity worthy of consideration; (2) progressive elaboration of the activity; and (3) activity implementation emphasizing evaluation and routine.

Despite suggestions to rethink the traditional model of lesson planning (Kagan & Tippins, 1992), "the literature contains few empirical data regarding the development of pre-service teachers' planning skills during their initial teacher preparation program" (Strangis et al., 2006). Moreover, most of the research on lesson planning has been conducted with elementary teachers.

Study Seven

Strangis, Pringle, & Knopf (2006) examined pre-service early childhood and elementary teachers' understanding of, and processes when, designing science instruction. The researchers analyzed written reflections and interviews to reveal the

beliefs and views the pre-service teachers had about planning. Participants acknowledged the importance of Standards and lesson objectives but planned in a sequence that found lesson activities before objectives. Despite the training participants received on a specific approach to planning (Pathwise Observation System), participants used two approaches to lesson planning. These two approaches varied in the use of Standards. Participants either planned their lessons first and then found Standards to match, or first consulted the Standards before making further planning decisions. This study examined how pre-service elementary teachers use Standards when planning science instruction, but did not examine students' beliefs about standards and whether or not the Standards influenced their planning decisions. Moreover, it was not mentioned whether or not the participants were introduced to additional science education reform documents (AAAS, 1990; 1993; NRC, 1996), nor if these documents had any influence on the planning of science instruction.

The previous studies are illustrative of the current research found on the lesson planning processes in-service and pre-service teachers pursue. I would like to point out that no studies exist that examine the lesson planning processes of novice pre-service teachers, pre-service teachers who are just entering their teacher preparation program. These studies demonstrate a gap in teacher education research and demonstrate the need for my study.

Science Education Reform and Teacher Beliefs

Contrary to what is taught to pre-service teachers, there appears to be no single most appropriate format for lesson plans (Kagan & Tippins, 1992). Variations in form

and sequence of lesson plans have emerged during subsequent centuries (American Association for the Advancement of Science, 1990; M. Hunter, 1994; Johnson, 2000; Trowbridge et al., 2004a), but the essential historical elements are still recognizable. The nature of instructional planning appears to vary with the subject and grade level to be taught, the instructional materials available, and the school context (C. M. Clark & Yinger, 1979). Lesson plans have become complex, reflective modes of thinking about planning and teaching.

In the current state of science education reform, it is imperative that pre-service teachers be taught to plan their lessons according to the recommendations of science education reform (AAAS, 1990; 1993; NRC, 1996) and state curriculum Standards. No studies have been found that examine lesson planning from the perspective of novice pre-service secondary science teachers. However, Haney, Czerniak, and Lumpe (1996) examined inservice teachers' intentions of using science education reform documents.

Haney, Czerniak, & Lumpe (1996) examined inservice teachers' use of science education reform strands to determine the factors influencing teachers' intentions to implement the recommendations. Teachers' attitudes toward the reform recommendations were found to be the greatest contributor to behavioral intention to implement the science education reform strands. This study provided suggestions for introducing science education reform documents to pre-service and inservice teachers. Findings suggest that teacher preparation programs address the need to foster positive attitudes towards the goals of science education reform.

Fostering positive teacher attitudes is often difficult because, as Pajares (1992) wrote, teachers are "insiders in a strange land" and "students become teachers unable,

and subconsciously unwilling, to affect a system in need of reform” (p.322). Boyd and Wandersman (1991) argue that behaviors are harder to change once habits have been established. Haney, Czerniak, and Lumpe (1996) suggest “teacher pre-service training may be the most timely period to provide opportunities for students to establish favorable beliefs regarding the nature of science teaching” (p.987). Understanding the belief structures of teachers and teacher candidates is essential to improving science teacher preparation and to creating lasting reform.

Clark and Peterson (1986) suggest that to better understand teacher behaviors, research should focus on the things and ways that teachers believe (C. Clark, 1988; Cole, 1989; Fenstermacher, 1979, 1986; Nespor, 1987; Pintrich, 1990). This view is based on the assumption that beliefs are the best indicators of the decisions individuals make throughout their lives (Bandura, 1986; Dewey, 1933; Nisbett & Ross, 1980; Rokeach, 1968). Pintrich (1990) suggests that beliefs will prove the most valuable psychological construct to teacher education.

Teacher beliefs are a significant factor in motivating a change in teaching behavior (Tobin, Tippins, & Gallard, 1994). Calderhead and Robson (1991) reported that pre-service teachers held vivid images of teaching, from their own experience. These images impact how pre-service teachers interpret the methods and strategies introduced to them in classrooms and teacher preparation courses. The ideas of education held by pre-service teachers play a part in their decision-making as teachers. Nespor (1987) argues that beliefs are more influential than knowledge in determining how individuals organize tasks and define problems. Science teacher preparation programs cannot afford

to neglect the beliefs of pre-service teachers (Pajares, 1992), especially beliefs about reform and the use of science education reform documents.

When pre-service teachers choose to follow or reject recommendations of science education reform because of their beliefs, they are exhibiting personal agency. Personal agency is a term that is derived from social cognitive theory. Bandura defines personal agency as “acts done intentionally” (Bandura, 2001). An intention is a representation of a future course of action to be performed. The core features of agency empower people to make choices in their self-development, adaptation, and self-renewal with changing times. Bandura states, “among the mechanisms of personal agency, none is more central or pervasive than people’s beliefs in their ability to exercise some measure of control over their own functioning and over environmental events” (2001, p.9). Pre-service teachers exhibit personal agency when making decisions about lesson planning and their implementation of reform practices.

Burns and Dietz (2000) report that within the rule structure of social systems, there is a lot of personal variation in the interpretation, enforcement, adoption, circumvention, and even active opposition of rules. Science education reform documents and lesson plan templates are examples of the some of the rule structures of science teacher education. Pre-service teachers exhibit personal agency when they choose which rules to follow, Standards to meet, theories to adopt, and procedures to oppose. Pre-service science teachers do not interpret science reform recommendations equally. To understand the lesson planning processes of pre-service science teachers it is important that both their practices and beliefs be examined. Pre-service teachers may choose to include Standards and excerpts from science education reform in their lesson plan

documents, however their beliefs about science education reform documents are the predictors of future behavior.

CHAPTER III: METHODOLOGY

Introduction

This chapter addresses the rationale and utilization of a collective case study approach to frame the research. A constructivist theoretical framework guided this inquiry. Constructivism is a theory that explains how learners make sense of their environments and experiences to create their own knowledge (Fosnot, 1992; Kim & Sharp, 2000). In this study, the following research questions were pursued to make sense of novice pre-service secondary science teachers' planning practices.

1. What processes do novice pre-service secondary science teachers pursue as they engage in lesson planning?
2. Does novice pre-service secondary science teachers' planning during field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?
3. What sources do novice pre-service secondary science teachers consult in making decisions about planning and which of those sources influence their planning decisions?
 - *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)
 - *Science for All Americans* (American Association for the Advancement of Science, 1990)
 - *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007)

- *National Science Education Standards* (National Research Council, 1996)
- *Tennessee's Next Generation Tools for Teaching Standards-Based Science*, (Audet & Jordan, 2003)
- *Tennessee's Next Generation Tools for Teaching Standards-Based Science CD*, version 1.4 (Jordan & Audet, 2007)

Statement of the Problem

Lesson plans are introduced in every teacher education program, are used in teacher evaluations, are often examined by principals, and provide insight into a teacher's practices. In light of No Child Left Behind (NCLB) mandates, the role of teacher as planner has become increasingly important (Reese, 2004; Strangis, Pringle, & Knopf, 2006). Many authors have pointed to the importance of planning because it forms a knowledge base for scaffolding instruction that reflects the essential features of reform based practice (Jimenez & Sanmarti, 1995; Sanchez & Valcarcel, 1999; Strangis, et al., 2006; Tobin & Tippins, 1993). Furthermore, lesson plans play an important role in teacher preparation and teacher evaluations.

Little attention has been given to how pre-service teachers plan for instruction (Samaras, 2000). Strangis, Pringle, and Knopf argue "literature contains few empirical data regarding the development of pre-service teachers' planning skills during their initial teacher preparation program" (Strangis et al., 2006, p.73). One of the objectives of this research is to answer this call, which is to describe how pre-service science teachers plan for instruction and the processes that influence them as they engage in planning their first

science lesson. I argue that investigating and understanding the processes of lesson planning will provide us with knowledge and insights needed for preparing future secondary science teachers.

Methodology

A qualitative methodology guided my inquiry on how pre-service teachers plan instruction and the processes that influence their planning decisions. Qualitative research “involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or to interpret, phenomena in terms of the meanings people bring to them” (Creswell, 1998, p.3). This study examines the planning processes of pre-service secondary science teachers and attempts to interpret the process and decisions of the participating teachers.

A collective case study methodology was chosen for this study because of the opportunity to use triangulation (Yin, 2003). Yin states that any finding or conclusion in a case study is likely to be “much more convincing and accurate if it is based on several different sources of information” (2003, p.98). Multiple sources of data will be used for “data triangulation” (Yin, 1994) in order to understand the process novice pre-service secondary science teachers use when planning and the sources they consult when making planning decisions. The evidence from collective case studies is often considered more compelling, and the overall study is therefore regarded as being more robust (Herriott & Firestone, 1983). The bounded system for this research is participation in the TPTE 353 course over a 4-month period (Creswell, 1998).

Context of the Study

The TPTE 353 course in which participants were enrolled was initially due to the involvement of the University of Tennessee's Science Education department participating in a Department of Education Title II Teacher Quality Urban Impact Grant, from 2000-2005. The Project Director invited all interested college faculty to design innovations in pre-service teacher preparation to improve urban teaching and to strengthen and develop university/school partnerships. The grant goals were to better equip pre-service teachers with the necessary knowledge, skills, and abilities to succeed in working with diverse student populations. Initially two approaches were designed in the secondary science program: one based on a co-teaching model and one to create a curricular innovation resulted in this course for secondary science pre-service teachers. There are several reports on these efforts (Melear, Wentworth, & Perkins, 2005a, 2005b; Melear, Wentworth, Perkins, Daniels, & Stewart, 2005; Perkins, Melear, & Wentworth, 2006; Sleeter, 1995). This study focused only on data from the 2007 cohort of TPTE 353. After the Department of Education Title II Teacher Quality Urban Impact Grant ended, the curricula innovation TPTE 353 was continued and is sustained as a required course.

The course reported on occurs in the spring semester prior to the full year of internship and is only for novice pre-service secondary science teachers. The course requires students to complete twenty-four hours at a community-based field agency serving an urban population. From 2005-2007, TPTE 353 students were placed in a local urban YMCA in an after school program that serves elementary through secondary "at risk" children. The purpose in placing students with such an agency was to provide familiarity with urban children, communities and situations outside the school

environment. According to the Tennessee Teacher Licensure Standards for Professional Education guidelines, field experiences linked with community agencies and services addressing the needs of urban students and their families correlate with NCATE, INTASC, and NSTA standards as well as principles proposed by UNITE (Urban Network to Improve Teacher Education). As one NSTA report concluded

The best programs involve prospective teachers in the community early and provide methods and opportunities for the teachers to become familiar with available resources. They require demonstrated interaction with families and community resources to involve them in science teaching during field experiences and may require service learning in some courses. Such programs require evidence that candidates understand the cultures of their students and use examples and references from different cultures to involve these students (National Research Council, 1996, p. 36).

Dr. Claudia Melear (Melear, Wentworth et al., 2005a, 2005b; Melear, Wentworth, Perkins et al., 2005; Perkins et al., 2006) got the idea for the course from Sleeter (1995):

In the second course (in Sleeter's pre-service teacher education program), students completed a fifty-hour field experience. I used to place them mainly in urban classrooms but now place most students in urban community organizations, such as community centers, field-based tutoring programs, or minority-run social service agencies. Placements are those in which the population being served as well as those running the agency represents a low-income minority group. My students will have specific service work to do under the direction and supervision of a staff person,

and their work will allow them to talk informally with some of the clients (usually children and youth) (p. 424).

TPTE 353 was designed to simultaneously address the following numerous National and State Standards and the Tennessee Framework:

- Tennessee Standard 3: Candidates understand how students differ in their approaches to learning and create instructional approaches that are adapted to diverse learners
- Tennessee Framework: Indicator C: Adapts instructional opportunities for diverse learners
- INTASC 3, National Science Teachers Association (NSTA) Standards 3, 5, 7

TPTE 353 met once a week for ninety minutes during the spring of 2007. During the semester students were required to spend a minimum of 24 hours in their field placement and write a science lesson plan. The course culminated in a final activity with YMCA children in which some of the novice pre-service secondary science teachers taught their science lesson plans. Others taught more common science lessons on aquaria, pulleys, and bacteria. Standards-based lesson planning software, *Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4* (Audet & Jordan, 2007), was used in TPTE 353 to help pre-service science teachers with the science lesson plans they could design for their field placements or for later use. Templates and procedures found in Tennessee's Next Generation Tools for Standards-

Based Science Teaching CD were used as a primary resource to introduce novice pre-service secondary science teachers to lesson planning and to enable them to develop classroom learning experiences that are grounded in science education reform documents, *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993), *Science for All Americans* (American Association for the Advancement of Science, 1990), *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007), and *National Science Education Standards* (NSES) (National Research Council, 1996). The standards-based template used by participants can be found in Appendix B.

This lesson planning template emphasizes learning through guided inquiry using the 5E learning cycle model (Trowbridge et al., 2004b), and targets higher order thinking skills (Tennessee Science Teacher Association, 2006). Along with guidance on lesson planning, this CD provided novice pre-service teachers with multiple teaching resources such as science education links to the internet, Web Quests, sample lesson plans, and links to science reform documents. The table of contents for this CD is displayed in a concept map in Appendix C.

Participants

The majority of teacher candidates from this southeastern university do not come from backgrounds similar to those of students they are typically assigned to teach in their first years – urban students in high need schools. Tennessee’s teacher turnover statistics closely mirror the national figures with 46% of novice teachers leaving the profession

within the first five years (Alliance for Excellent Education, 2005). In urban settings, the figures equal or exceed the statewide statistic of a 20% annual teacher turnover rate.

Participants in this study had already obtained an undergraduate degree in Biology or Physics and were currently enrolled in the process of obtaining initial licensure in secondary science. In this rigorous teacher preparation program, candidates will complete a one-year internship with a range of professional development experiences while completing a prescribed set of courses. A portion of the initial licensure courses serve as prerequisites to interning, others are taken during the year-long internship, while others are normally completed following the internship. Following recommendations in the NSES, the University of Tennessee, Knoxville provides opportunities for practicing and pre-service teachers to:

- Develop effective ways to engage students in inquiry,
- Experience inquiry-based learning and teaching through observation and study of natural systems,
- Establish learning communities with K-16 colleagues,
- Supplement classroom learning through online research, discussion and collaboration,
- Develop expertise in curriculum, instruction, and assessment and evaluation in science and environmental education, as well as in interpreting and conducting research. (National Research Council, 1996)

The participants were selected because they had enrolled in a university pre-service science education course and would be designing their first science lesson plans during the initial licensure course. All participants were new to writing science lesson

plans, new to writing lesson plans using software, and had never been exposed to the 5E learning cycle. Teaching experience among the group ranges from those who have never planned and taught a lesson to those who have completed special education methods courses and technology methods courses in education. The demographics of this group of pre-service secondary science teachers are described in detail in Chapter IV.

The six pre-service secondary science teachers (n=6) included in this study self-selected to participate. The TPTE 353 course had twelve students enrolled, however only 6 students volunteered to participate in the study. This study documented the diverse variations and identified important common patterns among the lesson planning processes and decisions of participants in the TPTE 353 spring course.

Data Collection Methods

Anfara, Brown, and Mangione (2002) argue that “the purpose of analysis is to bring meaning, structure, and order to data” (p.29). To address the research questions, an interview protocol was utilized. Yin (1994) discussed design as “the logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of the study” (p.18). The research questions pursued in this study are aligned with data sources in Table 1.

Early in the spring semester, I met with the TPTE 353 students to introduce and familiarize them to *Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD, version 1.4* (Jordan & Audet, 2007) during a ninety minute class session. I introduced them to the lesson plan template (found in Appendix C) and various reform documents found on the CD. I provided students with instructions on navigating the CD,

Table 1. Alignment of Research Questions with Data Sources.

Data Source		Research Questions	
	1. What processes do NPSST pursue as they engage in lesson planning?	1a. Does NPSST planning during community field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?	1b. What sources do NPSST consult in making decisions about planning and which of those sources influence planning decisions? • <i>Benchmarks</i> • <i>SFAA</i> • <i>TN Standards</i> • <i>NSES</i> • <i>TN Next Generations CD</i>
Lesson Plans	X	X	X
Guided Reflection #1	X	X	X
Guided Reflection #2	X	X	X
Semi-structured Interview Questions			
1. Please tell me about yourself: Your year in school, your age, your major. What are you doing this semester?			
2. Are you doing any lesson planning this semester? Describe how that is going.	X	X	X
3. Have you had experience writing lesson plans prior to TPTE 353? Please describe.	X	X	X
4. What do you feel is the purpose of writing lesson plans?	X	X	X

X indicates the research question addressed by each data source.

Table 1. Continued.

Data Source		Research Questions	
	1. What processes do NPSST pursue as they engage in lesson planning?	1a. Does NPSST planning during community field placements correlate with the template introduced in TPTE 353 via standards-based science lesson planning software?	1b. What sources do NPSST consult in making decisions about planning and which of those sources influence their planning decisions? • <i>Benchmarks</i> • <i>SFAA</i> • <i>TN Standards</i> • <i>NSES</i> • <i>TN Next Generations CD</i>
Semi-structured Interview Questions			
You might remember writing your first lesson plan for SCED 353. I have a lesson plan you created and your reflection about lesson planning. Please look these over to refresh your memory. (Give student documents to read over.) I have some questions based on your reflection and lesson plan.			
5. In your reflection, you said you planned that lesson by... Please would you tell me a little more about what you meant by that?	X	X	X
6. In your lesson plan, you said _____. Please explain how you use the state standards.	X	X	X
7. In your reflection, you said that __ was difficult/easy for you. Please would you talk a little more about that? How about planning for the activity (hard/ easy)? How about evaluating your students (hard/easy)? How about evaluating your students (hard/easy)? How about writing objectives (hard/easy)? Follow up all responses with why or why not.	X	X	X
8. Describe how you would typically plan for a lesson. (Probe for sequence.)	X	X	X

X indicates the research question addressed by each data source.

Table 1. Continued.

Data Sources		Research Questions	
	1. What processes do NPSST pursue as they engage in lesson planning?	1a. Does NPSST planning during community field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?	1b. What sources do NPSST consult in making decisions about planning and which of those sources influence their planning decisions? • Benchmarks • SFAA • TN Standards • NSES • TN Next Generations CD
Semi-structured Interview Questions			
	9. Why do you think you plan a lesson in that order?	X	X
	10. What do you think is the most important part of the lesson plan? Why?	X	X
Provide a copy of the "Conceptual Design" concept map. During TPTE 353,			
	11. Please describe how TN's Next Generation Tools for Teaching Standards-Based Science CD has been beneficial.	X	X
	12. If the CD has been beneficial, why do you believe the CD has been beneficial?	X	X
	13. If the CD has not been beneficial, why do you believe the CD has not been beneficial?	X	X
	14. How many times would you estimate you use the CD per week?	X	X
	15. Do you see yourself using the CD after this course and field placement?	X	X
	16. Today, is there anything else you wish to tell me about lesson planning or use of TN's Next Generation Tools for Teaching Standards-Based Science CD?	X	X

X indicates the research question addressed by each data source.

Table 1. Continued.

Data Sources		Research Questions	
	1. What processes do NPSST pursue as they engage in lesson planning?	1a. Does NPSST planning during community field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?	1b. What sources do NPSST consult in making decisions about planning and which of those sources influence their planning decisions? • <i>Benchmarks</i> • <i>SFAA</i> • <i>TN Standards</i> • <i>NSES</i> • <i>TN Next Generations CD</i>
Semi-structured Phone Interview Question			
1. Do you have anything else you would like to tell me about what you think about lesson planning, the standards, or the CD used to help you plan your lessons?	X	X	X
X indicates the research question addressed by each data source.			

using the novice lesson plan builder, and provided a brief history of the four science education reform documents linked through the CD. I also provided students with forty-five minutes of exploration time using the CD, while I was present to provide assistance. The reform documents found on the CD were NSES (National Research Council, 1996), *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007), *Benchmarks for Science Literacy* (AAAS1993), and *Science for All Americans* (American Association for the Advancement of Science, 1990). Students were given time to ask questions and to begin designing their first lesson plan assignment for the TPTE 353 course. For five of the six participants, this was their first opportunity to write a science lesson plan. For two of the students, this would be their first experience ever writing a lesson plan. The lesson plan was not to be finished during this individual class time. Students would be given several weeks to complete and revise their first science lesson plan. TPTE 353 students were designing science lesson plans to be taught in their urban community field placements, later in the semester.

Upon my initial introduction to participants in January of 2007, I informed them of this study on pre-service teachers' lesson planning and asked them to participate. Those who agreed to participate gave me their e-mail addresses and later signed a consent form. The Participant Informed Consent Form can be found in Appendix D. Students were informed that participation would include sharing lesson plans, reflections, and participating in an interview. All students agreed to participate, n=12, however when asked to turn in their first lesson plan and reflection, only 6 responded with the requested documents, n=6.

Participants were asked to write a reflection on their lesson planning experience during the TPTE 353 course, both after writing their draft science lesson plan and turning in their final science lesson plan. Participants were given requirements to guide their reflections:

Written Guided Reflection Questions after Creating the First Draft Lesson Plan:

1. Describe your sequence for planning the lesson (what steps did you take 1st, 2nd, 3rd)
2. Describe how you used the CD,
3. What is your opinion of using the CD in lesson planning,
4. What do you think is the most important component of a lesson plan, why?

In February of 2007, a week after the first experience with the CD, participants e-mailed their draft science lesson plans and guided reflections to the researcher. In March and April of 2007, 30-minute semi-structured audio taped interviews were conducted with each individual participant using an interview protocol. The semi-structured interview protocol can be found in Appendix E. All audio taped interviews were conducted on The University of Tennessee campus, at the participants' convenience.

The pre-service teachers were also required to write a reflection on their final science lesson planning experience during the TPTE 353 course. Pre-service teachers were given requirements to guide their reflections:

Final Guided Reflection Questions after Creating the Finished Lesson Plan:
Please address each of the following questions using single spacing, in a document no longer than two pages.

1. Has your process of lesson planning changed during TPTE from the first to the final draft and if so please describe how?

2. Have your ideas about lesson planning changed from January until now? Please explain.
3. What part if any did Standards have to do with your lesson plan from the *National Science Education Standards*, TN State Standards, *Science for All Americans*, and/or the *Benchmarks for Science Literacy*?
4. Which of the Standards documents did you find most helpful if any and why?
5. Please list from the Standards documents the ones that you chose to read and how you used that information in planning your lesson.
6. Please list from which of these sources you chose not to read and explain why you chose not to read that particular information.

Participants e-mailed the final edited lesson plans and guided reflections to the researcher. Lastly, participants were asked to respond to a final interview conducted by the researcher via telephone in May of 2007. The final broad question was posed to participants to elicit any comments they would like to share. The researcher audio-taped and transcribed the phone interviews.

Final Broad Question:

Do you have anything else you would like to tell me about what you think about lesson planning, the standards, or the CD used to help you plan your lessons?

Data Analysis

When multiple cases are chosen, Creswell (1998) suggests a typical format for collective case studies. A thick description of the TPTE 353 course provides the setting for the cases. Within-case analysis provides a detailed description of themes or assertions found through the study of each participant or case. This analysis may suggest “unique themes to a case, or themes that are common to all cases studied” (Creswell, 1998,

p.252). Within-case analysis is followed by cross-case analysis which “examining themes across cases to discern themes that are common to all cases” (Creswell, 1998, p.250). The final phase is the interpretive phase, which reports “the lessons learned from the case(s)” (Creswell, 1998, p.63). This study follows the collective case study format suggested by Creswell (1998).

Yin (1994) discussed design as “the logic that links the data to be collected (and the conclusions to be drawn) to the initial questions of the study” (p.18). The research questions pursued in this study are aligned with data sources and are shown in Table 1.

Anfara, Brown, and Mangione (2002) argue that “the purpose of analysis is to bring meaning, structure, and order to data” (p.29). To bring meaning, structure and order to the data in this study, the principal researcher transcribed the audio taped interviews and conducted a text analysis of the lesson plans, student reflections, and interview documents using QDA Miner software (Provalis Research, 2005), after receiving training from the university Office of Instructional Technologies. Each document was broken into statements that captured the information relevant to the study. All documents were analyzed for commonalities and diverse variation. First, all documents belonging to each participant were analyzed for themes. Next, a cross-case analysis was conducted to look for patterns and commonalities. All documents have been analyzed for themes (Creswell, 1998). Pseudonyms are used to insure participant confidentiality when reporting results of the study. Themes are reported in Chapter IV.

Meeting the Quality Criteria

Once the analysis was complete, the principal researcher engaged in ‘member checking’ (Stake, 1995). The findings were shared with the participants in order to check with the source the trustworthiness of what was found in the analysis (Leitz, Langer, & Furman, 2006). Member checking, also known as respondent validation, allows participants to review findings from the data analysis in order to confirm or challenge the accuracy of the work (Creswell, 1998; Lincoln & Guba, 1985). This strategy establishes trustworthiness as it gives authority to the participants’ perspectives therefore managing the threat of bias (Padgett, 1998).

The member checking in this study involved sending participants the findings from the analysis via e-mail in order for them to identify which aspects of the data analysis best fit their perspectives. The participants were also given the opportunity to identify areas that may have been missed or misinterpreted. To some degree, the principal researcher engaged in ‘prolonged engagement’ (Creswell, 1998). Having participants engage in the process of one additional interview allowed the researcher to collect additional qualitative data increasing the trustworthiness of the findings (Lietz, Langer, & Furman, 2006).

CHAPTER IV: RESULTS

Organization of the Chapter

The Chapter is organized into three sections:

1. Basic demographic information
2. Presentation of within-case analysis.
3. Presentation of cross-case analysis of the six teacher participants arranged by the four research questions and a fifth section that presents themes developed from interview questions and reflective journal responses.
4. Discussion.

Basic Demographic Information

Case Study - Brandi

Brandi, a 22 year-old non-Hispanic White female, was a pre-service science teacher in her first semester of graduate school in The University of Tennessee's Track II program. Information on The University of Tennessee's science education program can be found in Appendix F. The syllabus for TPTE 353 can be found in Appendix G. Brandi held a B.S. degree in Biology and did not have any exposure to education methods or lesson planning prior to TPTE 353. During the spring of 2007, Brandi enrolled in three classes that would provide her with lesson planning experience. Along with the culturally relevant lesson plan written for TPTE 353 in the spring semester, Brandi wrote a unit plan consisting of five lesson plans for another education course and two lesson plans for a Special Education course. This was Brandi's first semester to be exposed to lesson planning and to be required to write a science lesson plan.

Case Study – Chase

Chase, a 28 year-old non-Hispanic White male, was a pre-service science teacher in his third semester of graduate school in The University of Tennessee's Track II program. Chase held a B.S. degree in Manufacturing and Engineering. He was working on his Master's degree in Education in order to teach Physics. Prior to enrolling in TPTE 353, Chase had been written four lesson plans in an Instructional Technology course and an additional lesson plan in a Special Education course. This was Chase's first semester to be asked to write a science lesson plan.

Case Study – Laura

Laura, a 23 year African-American female, was a pre-service science teacher in the last semester of her courses pursuing a B.S. degree in biology and in her first semester of courses in The University of Tennessee's Track II program. Laura held a B.S. degree in Biology and had written nine lesson plans in education courses prior to TPTE 353. Five of the nine lesson plans written composed a unit plan, one was a lesson plan incorporating instructional technology, and her ninth lesson plan was written for diverse learners in a Special Education methods course. TPTE 353 provided Laura with the opportunity to write her first science lesson plan. This was Laura's first semester to be exposed to Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007).

Case Study – Hazel

Hazel, a 27 year-old non-Hispanic White female, was a pre-service science teacher in her third semester of graduate school in The University of Tennessee's Track II program. Hazel held a B.S. degree in Biology and had been exposed to lesson planning

in two courses prior to TPTE 353. However, she had not previously been exposed to writing science lesson plans. This was Hazel's first semester to write science lesson plans using Tennessee's Next Generation Tools for Teaching Standards-Based Science CD.

Case Study – Karen

Karen, a 23 year-old Asian female, was a pre-service science teacher in her second semester of graduate school in The University of Tennessee's Track II program. Karen held a B.S. degree in Biology and had been exposed to lesson planning in three courses prior to TPTE 353. In her first semester of graduate school she had been assigned to write one instructional technology lesson plan, an environmental education unit plan consisting of five lesson plans, and three Special Education lesson plans for diverse learners. However, she had not previously been exposed to writing science lesson plans using the template found on Tennessee's Next Generation Tools for Teaching Standards-Based Science CD. Informational links found on the CD had been consulted as resources while writing her Environmental Education Unit Plan although she was not formally trained to use the CD prior to TPTE 353.

Case Study – Samantha

Samantha, a 43 year-old German female, was a pre-service science teacher in her first semester of graduate school in The University of Tennessee's Track II program. Samantha held a B.S. degree in Biology and did not have any exposure to education methods or lesson planning prior to TPTE 353. This was Samantha's first semester to be exposed to lesson planning, Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, and to be required to write a science lesson plan.

I have divided this part of the paper into three sections to communicate my findings from the three research questions.

Within-case Analysis

Research Question I Analysis

What processes do novice pre-service secondary science teachers pursue as they engage in lesson planning?

Several researchers on educational reform support the notion that teacher beliefs are precursors to change and that the teacher is the crucial change agent in paving the way to reform (Ajzen & Fishbein, 1980; Cuban, 1979; Fullan & Miles, 1992; Haney et al., 1996). According to Rokeach (1968), planning to behave in a predisposed manner is evidence of belief. Teacher preparation programs can ill afford to ignore the entering lesson planning beliefs and practices of novice pre-service teachers (Pajares, 1992, p. 322). To determine the processes that novice pre-service science teachers pursue as they engage in lesson planning, I analyzed each participant's first guided reflection, lesson plans, semi-structured interview, final guided reflection, and final phone interview.

Chase

Chase and Hazel followed a similar process when planning science instruction. Chase said that after he chose a topic he researched the topic by reading his Physics textbook and browsed the internet "by doing this I gained insight on how other teachers have taught this subject" (Chase, First Guided Reflection, March 2, 2007). Next, he brainstormed activities he could have students do "I thought through possible worksheets, demonstrations, and verbal discussions." Finally, he accessed Tennessee's Next

Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Audet & Jordan, 2007) and began examining how the lesson he designed in his head lined up with the Standards documents listed on the lesson plan template “while looking through some of the Standards, I made minor adjustments to my lesson plan which I made in my head.” Using the CD template to plan science instruction helped Chase align his lesson with the Standards found in the reform documents located on the CD. In the final phone interview, Chase stated “using the templates and the CD has helped me hone in on what is expected of my lesson plans. Otherwise, I would have a piece of paper and I would just sketch down a couple of ideas. My lesson plans are starting to become more detailed (include specific ” (Chase, Phone Interview, May 28, 2007). Chase’s statements suggested that he used Standards documents in his planning process and that he believed his use of the CD template improved the amount of information included in his lesson plans by requiring him to include details he previously would not have considered, such as extension activities.

Hazel

Hazel’s responses represented a focus on content in the planning process. During the act of developing lesson plans, Hazel explained that she begins lesson planning by deciding on an idea she would like to convey to her students and then supplements this idea with information found in a college textbook. She stated, “for my science lesson plan, I had an idea of what I wanted to convey, and then I found several chapters in this one book (college textbook) that I thought would supplement what I wanted to get across” (Hazel, Semi-structured interview, April 11, 2007). The textbook she relies on

gives her ideas of what to teach and serves as a reference for students. Her philosophy on using TN Curriculum Standards is “I have an idea of what I want to get across and then I look to make sure that it fits the Standards.” In her plans for TPTE 353 she stated that she tried to have a fun activity in each of her lessons and used the internet to look for these classroom activities. In Hazel’s planning process, assessment comes last, “that’s always at the end of my things to deal with. The fun activity first” (Hazel, Semi-structured interview, April 11, 2007.) When asked why she plans this way, Hazel replied “probably because it is unorganized and that’s the way I am. It is haphazard and something good will come out of it at some point” (Hazel, Semi-structured interview, April 11). Hazel’s statement displays that assessment is the last step in her planning process and that assessment does not influence other stages in her planning. Hazel’s commitment to including a fun activity in each of her lessons accompanied by her disinterest in assessing student learning indicates that she is biased toward affective variables and possibly undervalues cognitive/ academic variables, a behavior characteristic of beginning teachers (Porter & Freeman, 1986; Weinstein, 1988).

Karen

Karen explained that she begins lesson planning by using the Tennessee Curriculum Standards to choose her topic. The Standards are used as a checklist of items she needs to teach. She stated “I want to make sure that I do the Standards and the topic first. I don’t want to cover something that’s not on the checklist” (Karen, Semi-structured interview, April 18). If she feels she does not understand the topic completely, she uses a high school textbook to “brush up” on content knowledge, similar to how Hazel uses a

textbook in her planning process. Next, she goes on-line and searches for lesson plans related to the chosen standard and topic. Depending on her preference, she may use an entire lesson found on-line or incorporate bits and pieces of different lessons found on-line or in resource books. After searching for ideas and activities, Karen decides how the lesson will unfold in the amount of class time she is given while contemplating what role assessment will play in her lesson.

Throughout planning in the back of my head I'm asking myself if I have an assessment. So then I write how I'm going to start, this is how it's going to be in the middle, this is how it's going to end. Then I would go back and decide upon my assessment (Karen, Semi-structured interview, April 18, 2007).

Once the Standards, topic, activity structure and assessment have been decided upon, Karen writes the objectives for her lesson “objectives are what I hate so I will do that last, just because I haven’t grasped them yet” (Karen, Semi-structured interview, April 18, 2007). Finally, Karen considers how she will design extension activities and how to support diverse learners. Karen’s comments demonstrate the importance she places on assessment and Standards when planning instruction. However, when I asked Karen why she plans the way she does, she commented, “you don’t want to turn in a lesson plan without any standards. I know that you cover stuff in class that’s not on the standards, but if I’m turning it in for an education course I want to be able to fill that standard part out” (Karen, Semi-structured interview, April 18, 2007). This statement contradicts a comment given by Karen previously in the semi-structured interview, “I don't want to cover something that's not on the checklist.” Bandura claims that the power to originate actions for given purposes is the key feature of personal agency and that personal agency operates within a broad network of sociostructural influences (2001).

That is, when pre-service teachers make decisions to oppose university or reform recommendations, they are exhibiting control over institutional requirements. Here, Karen exhibits personal agency by exercising her ‘self-influence’ (Bandura, 2001, p.15) to choose when she will include Standards in her lesson plans.

In her final guided reflection, Karen shared that her thoughts on lesson planning had changed over the semester. She first thought of lesson plans as an itinerary and guide for the day. Karen shared that she now realizes that lesson plans must be written so that other teachers or possible substitute teachers can follow them, and must contain more detail than she originally thought. Another challenge for Karen is choosing appropriate assessments. The 5E Model now helps Karen design her science lesson plans “the 5E Model helps me break down my lesson into categories to make sure I am incorporating all five aspects into my lesson” (Karen, Final Guided Reflection, May 14, 2007). Karen’s thoughts about lesson planning changed as well as her process, the steps she takes when planning instruction. The only difference in her planning process is that, “in the future I would make my assessment before I start the activities for the lesson” (Karen, Final Guided Reflection, May 14, 2007).

Samantha

When Samantha was asked to write a science lesson plan she first thought of her topic, came up with a list of materials, and then consulted the Tennessee Curriculum Standards. Next, she considered activities that would be created “according to the age of the children” (Samantha, Semi-structured interview, April 18, 2007). Samantha conducts Google searches on the internet to find interesting classroom activities. She also visits the

library to find interesting books and stories to introduce her lessons. The resources Samantha finds at the library and on-line help her plan how she will plan each lesson and engage her students.

Then in the end, sitting down I would have to think of everyday okay, how do I want to bait my students today, maybe today I bring in the collection of stones and they have to figure out which one could be from a volcano, which ones definitely not from a volcano, and the next day do a different activity building on the knowledge they have acquired the day before (Samantha, Semi-structured interview, April 18, 2007).

Samantha explained her thoughts on this process “it is very time consuming but I wouldn't know how to do it differently.”

After being introduced to Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD, Samantha changed her approach to planning science lessons. Samantha started to consult the state Standards first “I think since I have this tool, now I would look up the Standards, *Benchmarks*, and look up what I'm expected to do. I would use the CD to make sure that I don't leave out anything.” Samantha now exhibits a desire to plan according to Standards.

Laura

Laura explained that she begins lesson planning by consulting Tennessee Curriculum Standards “as far as picking Standards first, its just because its been stressed now in the education system that you have to meet the required Standards.” The education system and Standards were the only factors that my research questions were able to elicit that Laura described as having an impact on her process of planning. After choosing state standards, Laura then determines how she will assess student understanding of the content before planning the details of the assessment. Choosing

Standards and how to assess Standards are her first two priorities, “well I think it was easy just because I know they say beginning teachers need to plan the lesson, then figure how they are going to assess, but I usually look at what I want to assess and then try to plan the lesson.” Laura demonstrates personal agency through her choice to plan science instruction using a process that makes sense to her.

For the assessment of her first science lesson plan, Laura chose a poster project for students to demonstrate that they knew the difference between animal and plant cells. She explained that just four years ago when she was a high school student that hands-on activities, cooperative learning, and games were activities she enjoyed. This influenced her lesson planning, “I realize that those are the things that kept me interested in my classes. I want the same for my students.” Nespor (1987) argues that pre-service teacher beliefs draw their power from previous events that color their comprehension of subsequent events. Such episodes played a key role in the lesson planning process of Laura, who chose to do hands-on science because of her own experience as a student.

After planning the assessment, Laura plans what she will teach step by step in a very precise manner “I have ‘the student will’, ‘the teacher will’, it is very precise.” Once she has planned the Standards, assessment, and detailed steps of teaching, she then writes the objectives. She shared that writing objectives is hard because it is difficult to match objectives, verbs, and assessment, “you’ve got to pick the right verb and the right project that fits the objective to meet the criteria that you are setting for yourself, it is hard.” Laura’s comments demonstrate the steps in the planning process with which she is comfortable and identify the step she finds most difficult.

Brandi

Brandi explained that she begins lesson planning by brainstorming about possible topics “I think the topic comes first. I think if they (students) know the material then they’re going to probably meet most of the Standards.” Brandi expressed that she does not want to teach to the Standards as the CD template suggests, but believes that by following a Biology textbook her lessons would match the standards “I don’t want to teach to the Standards, but I feel like if I’m covering say what’s in a textbook, for 10th grade Biology students, then its going to pretty much match what the standards are asking for, most likely if its been approved by the state to be a textbook.” When asked why she plans this way, Brandi stated that the reason she plans this way is because “I just like doing it” (Brandi, Semi-structured interview, April 4).

During the semi-structured interview, Brandi described the process that influences her as she engages in lesson planning.

I don’t brainstorm on paper or anything. The wheels start turning. Just like when you get excited about something, you know, and I get all of these grand ideas, and probably half of them won’t work, and maybe a couple of them will, so I just think what will be the most clear. How will students best receive the information, how do students learn, and choose a way of teaching that topic that would hopefully help them to learn. Standards-Lesson-Assessment and so-on. (Brandi, Semi-structured interview, April 4)

Brandi did not mention being influenced by any process or template that was shown to her in her coursework, nor did she mention any of the Standards documents as being influential. Brandi’s decision that Standards would not influence her lesson planning process shows her determination to plan autonomously. Pajares argues that “the earlier a belief is incorporated into the beliefs structure, the more difficult it is to alter, for these beliefs subsequently affect perception and strongly influence the processing of new

information” (1992, p. 317). Newly acquired beliefs are vulnerable. This was Brandi’s first education course and already she is opposed to planning according to Standards, a practice science reform documents recommend (AAAS, 1993; NRC, 1996; SFAA, 1990). Munby also saw the power of pre-service teacher beliefs and explained that the power of beliefs can easily outweigh the clearest and most convincing contrary evidence (1982). Thus, Brandi’s beliefs could become problematic in view of teaching to the Standards, however her beliefs may be meaningful for her and even have a positive effect on student learning.

A brief description of participants can be found in Table 2.

Table 2. Participants.

Pseudonym	Age	Initial Licensure Area	Race	Sex	Number of Previous Education Courses that Taught Lesson Planning
Brandi	22	Biology	Caucasian	Female	0
Chase	28	Physics	Caucasian	Male	2
Laura	23	Biology	African American	Female	2
Hazel	27	Biology	Caucasian	Female	2
Karen	23	Biology	Indian	Female	3
Samantha	43	Biology	Caucasian/ ESL	Female	0

Research Question IA Analysis

Does novice pre-service secondary science teachers' planning during field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?

The standards-based lesson template used in TPTE 353 requires students to consult three science reform documents *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) *Science for All Americans* (American Association for the Advancement of Science, 1990), *National Science Education Standards* (National Research Council, 1996), as well as the *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007), when designing science lessons. Teachers are to align their lessons with the Standards presented in these documents. I analyzed participants' lesson plans, guided reflections, and interviews to determine if novice pre-service secondary science teachers' planning during field placements correlates with the standards-based planning template introduced in TPTE 353. Participants in this study were asked if they read all of the standards-based documents, what part if any did Standards have to do with their lesson planning, and how they chose to use the information in planning a lesson.

Brandi

Brandi explained that she understood the importance of implementing and meeting Standards, however, the Standards had no influence on how she planned her lesson.

It sounds bad, but I don't really care about the Standards, I know I need to. And I know they're important because they are there for a reason. But, I care more

about getting the kids involved and making sure that they are learning. I feel that if planning becomes dependent on the Standards, students are going to miss out on a lot of important things like critical thinking and problem solving. (Brandi, Semi-structured interview, April 4, 2007)

Thinking critically is much more important than memorizing information that a Standard says is important. (Brandi, Final Guided Reflection, May 16, 2007)

The Standards really had no influence on what I wanted my lesson to be. I simply found the Standards that aligned with what I wanted to teach instead of starting with a Standard and trying to cater a lesson plan to it. (Brandi, Final Guided Reflection, May 16, 2007)

Brandi claimed that the Standards documents did not influence her planning, however she did insert Standards found in the NSES and excerpts from both *Science for All Americans* (SFAA) (American Association for the Advancement of Science 1990) and *Benchmarks for Science Literacy* (BSL) (AAAS, 1993) into her draft and final lesson plan. Both her draft and final lesson plan included a lesson overview, instructional goals, a formative assessment, notes of how she would introduce, teach and conclude her lesson, teaching resources, accommodations for special learners and enrichment activities.

Brandi expressed uncertainty about assessing student understanding “if I had to sit down and come up with an effective way of assessing them, I think that would probably be a little bit more difficult. I think figuring out what is fair to ask them, would be most difficult” (Brandi, Semi-structured interview, April, 4, 2007). The assessment she designed consisted of discussion and participation in the activity. She also expressed that she valued having enrichment activities by stating “since teachers have no definite way of predicting how a lesson will play out, it is important to have additional information or activities for students if the planned lesson finishes earlier than expected.”

Brandi's draft and final lesson plans were very similar. The only changes made were corrections in grammar and punctuation. Brandi's lesson plans do not reflect her opinion of Standards, in both her guided reflections and interviews Brandi clearly stated, "the Standards themselves really had no influence on how I planned my lesson."

Brandi's lesson plan included Standards however she made it clear that they had no impact on her lesson planning decision-making. Standards become influential only if they are implemented, Brandi chose not to implement the Standards.

Chase

The draft version of Chase's lesson plan incorporated Standards, a brief description of how his lesson would unfold, and a brief post-assessment. The first draft of Chase's lesson plan can be found in Appendix H. This lesson plan serves as a sample of the draft lesson plans provided by participants.

A general questioning of each of the 6 types of simple machines will be asked, and the students will be encouraged to participate in answering the questions. (Chase, Post-assessment, Draft Lesson Plan, March 25, 2007).

Chase's final lesson plan matured to include a pre and post assessment that would provide him with evidence of student learning. The final draft of Chase's lesson plan can be found in Appendix I. This lesson plan serves as a sample of the final lesson plans provided by participants and illustrates how Chase's lesson plan evolved during TPTE 353.

The day before this lesson on simple machines is presented; a pre-assessment of their knowledge will be given in the form of a quiz. This quiz will be six questions long, having an everyday picture example of each of the six machines illustrated. The student will be asked to identify the object, identify the simple machine associated with it, and illustrate the forces associated with each machine. (Chase, Pre-assessment, Final Lesson Plan, May 30, 2007)

With the remaining five minutes left, I will hand out a quiz. On the left hand side of the paper there will be six different objects illustrated, one per each of the simple machines. The students will have to identify the object, identify the classification of the object associating it with the simple machine, and will have to describe the forces associated with each object. (Chase, Post-assessment, Final Lesson Plan, May 30, 2007)

Four instructional goals were added to his final draft. Other aspects added were content notes of what would be covered during the class period, modified accommodations for diverse learners, relevant state comprehension testing items, a new enrichment activity, and time for students to explore using pulleys. All of these additions aligned his science lesson plan with the standards-based planning procedures taught in TPTE 353. The attributes of Chase's final lesson plan reflect a student-centered approach to teaching. Chase modified his lesson to meet the needs his students. By adding accommodations for diverse learners, relevant TCAP test items, and a revised enrichment activity, Chase exhibited an understanding that teaching and learning are nested within a broader education system. The choice to add these items to his plan of instruction also reflects how Chase is understanding his role and relationships with the classroom, school, community, and the profession. His understanding was further exemplified through his appreciation of Standards-based planning.

With gathering the Standards from other resources, Tennessee Curriculum Standards and NSES, I have started to see the benefit of using this resource. Writing a lesson plan is a bit like writing a research paper, many different resources. At first it helps me brainstorm, then with the linked resources, it helps to provide valid information. The template has everything labeled and well laid out so entering the information goes in the correct area. (Chase, Final Guided Reflection, May 30, 2007)

In the final guided reflection, Chase shared his opinion of using each science education reform document suggested by the lesson template found on Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Audet & Jordan, 2007).

The Tennessee Curriculum Standards were the major standards I spent time with. I assumed that most of the other Standards are met if the state standard is met. Actually, when I was first looking to create a lesson, I looked to the state standards to give me ideas of lessons to present. (Chase, Final Guided Reflection, May 30, 2007)

Science for All Americans was a bit more informative for me, and I used it to supplement by knowledge of the subject. (Chase, Final Guided Reflection, May 30, 2007)

Chase used science education reform documents in the beginning stages of his planning process, during which he deepened his content knowledge and chose a developmentally appropriate concept on which to base his lesson. Meeting course requirements was not Chase's only purpose in consulting Tennessee Curriculum Standards and SFAA. In Chase's lesson planning process, science education reform documents were used to inform planning decisions.

Laura

Laura planned her lessons according to Tennessee Curriculum Standards and NSES and felt that she would be held accountable for teaching to them. She found the state Standards to be most helpful.

One thing that I would like to say about the Standards in lesson planning is that it helps you realize that you're becoming very accountable for using Standards and meeting the Standards of Tennessee and the NSES. The Standards just help me understand how I'm being held accountable in my teaching. (Laura, Phone Interview, May 16, 2007)

Laura consults science education reform documents for accountability reasons. She used the state Standards as a checklist. That is, Laura views Standards as a list of items that need to be taught in her science classroom. If she teaches everything on the list, then she is meeting her requirements as a teacher.

The CD also recommends teachers develop instructional goals and a rubric to assess specific levels of student performance. Laura developed six instructional goals for her lesson on cells as well as a rubric to assess four features of the poster project assessment. Laura's planning during community field placements correlated with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software.

Hazel

Hazel found it difficult to plan her science lesson using Standards, specifically she found it difficult to match Standards with her lesson plan. She found the lack of Standards on specific topics frustrating "not all lessons are going to follow or be part of state or national Standards. That does not however make those lessons unnecessary." Hazel also expressed that she would not incorporate the K-12 standards into her lesson plan "I'm teaching high school. I don't care what they do in Kindergarten. I'm sorry. Not that I don't care, but it is just not what I'm teaching."

Hazel did not incorporate information from *Science for All Americans* into her lesson plan and chose not to develop a rubric for assessment. Instead, she only chose to consult *Benchmarks for Science Literacy*, NSES, and Tennessee Curriculum Standards. Over the semester Hazel added detailed instructional objectives and learning goals to her

lesson plan, developed three opportunities to assess student understanding, developed detailed questions to ask students, and elaborated on the content notes in her science lesson plan.

Karen

Karen found Standards documents to be beneficial. She used the Tennessee Curriculum Standards to determine the appropriate content to present to each grade level “I’d say that consulting standards is the first or the second step in my planning process.”

Karen used the NSES and *Benchmarks* to fill in the lesson plan template

I looked at the state standards first to see if the topic I wanted to teach was included in the standards. Next, I planned my lesson. Then, when I was filling in the boxes on my template I read the National Science Standards and *Benchmarks* to find the standard that fit my lesson. (Karen, Semi-structured interview, April, 18, 2007)

Karen explained that she preferred using the state standards because they were concise and to the point. She felt the other documents were too broad.

Karen’s lesson plan evolved over the semester to better correlate with the standards-based lesson plan template. Karen included Standards and content knowledge found in the Tennessee Curriculum Standards, NSES, *Benchmarks for Science Literacy*, and *Science for All Americans*. She became more comfortable using a rubric to assess student understanding. Karen’s final lesson plan presented the details of her lesson, not just an overview. She even included specific questions she planned to ask students. All five phases of the 5 E model were labeled and described. Karen showed further consideration of how she would accommodate special learners by providing them with typed notes. She inserted diagrams, photos, and a formative assessment to more fully

communicate the details of her lesson plan. The largest difference between Karen's draft and final lesson plan was that she decided to only introduce the process of mitosis in a single class period, instead of attempting to introduce both meiosis and mitosis.

Samantha

Samantha chose to consult each of the four documents suggested on Tennessee's Next Generation Tools for Teaching Standards-Based Science CD. She commented "I read them all after I created the lesson plan. My lesson plan was planned backwards, fitting an idea of a project into the Standards instead of using the Standards to design a project." Although use of the Standards documents and designing an activity was not difficult for Samantha, designing an assessment presented a challenge. Samantha had never before been exposed to creating rubrics for assessing student understanding. After developing her first rubric in the draft of her first science lesson plan, Samantha's professor helped her understand benefits of assessing students via rubrics. Samantha explained, "Now I know that rubrics are also important for the kids because they get to see the rubrics. They see what the teacher wants them to do in order to get a good grade so they can work their way up with a project."

Samantha's understanding of planning also changed as a result of using the lesson template found on the CD. Samantha described her thinking on lesson planning prior to using the CD "It was easy but I was not so serious about it. That's why it was easy." She went on to explain how her thoughts on lesson planning have changed "if I were to plan a lesson for a school, I think I would have to focus more on academics and not just the creativity part of it."

The final lesson plan developed by Samantha integrated science with a number of other subjects. She integrated standards in English, Language Arts, History, Art, Mathematics, Geography, Social Studies, and Technology. She developed concise instructional goals, detailed plans for each minute of her lesson, and elaborated on enrichment activities and lessons to follow her first science lesson. Samantha followed the lesson template very closely. She entered information into every section of the template without leaving any blank. After following the lesson template so carefully, she exclaimed, “yes, my thoughts on lesson planning have changed. Now I have a list of what students should know by the end of a specific grade. I have had a little glimpse at lesson planning and have experienced how time-consuming the process is.” Prior to TPTE 353, Samantha had not been introduced to writing science lesson plans or to science Standards. Now she claims she, “has a goal to work towards.” The sources consulted by pre-service teachers while planning are found in Table 3.

Research Question II Analysis

What sources do novice pre-service secondary science teachers consult in making decisions about planning and which of those sources influence their planning decisions?

- *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)
- *Science for All Americans* (AAAS, 1989)
- *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007)
- *National Science Education Standards* (National Research Council, 1996)
- *Tennessee’s Next Generation Tools for Teaching Standards-Based Science*, (Audet & Jordan, 2007)

Table 3. Sources Consulted by NPSST While Planning.

	Brandi	Chase	Laura	Hazel	Karen	Samantha
National Science Education Standards	X	O	X	X	X	X
TN Curriculum Standards	X	X	X	X	X	X
Science for All Americans	X	X	X	X	O	X
Benchmarks for Science Literacy	X	O	X	X	X	X
TN Next Generations Standards-Based Science CD	X	X	X	X	X	X
Other	O	Textbooks, internet	O	Textbooks, internet	Textbooks, DMS CD, Project WILD	Library books, pictures, own children

*X indicates a source consulted in the planning process

*O indicates a source that was not consulted in the planning process

The lesson planning template used in TPTE 353 requires teachers to consult three science reform documents when planning science instruction, *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) *Science for All Americans* (American Association for the Advancement of Science, 1990), *National Science Education Standards* (National Research Council, 1996), as well as the *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007). Students in TPTE 353 are required to use Tennessee's Next Generation Tools for Teaching Standards-Based Science CD (Audet & Jordan, 2007) when planning science instruction, but are also allowed to consult references they find on their own. Calderhead and Robson (1991) reported that pre-service teachers held vivid images of teaching from their own experiences as students, images that influenced interpretations of particular courses and classroom practices and played a powerful role in determining how they translated and utilized knowledge they possessed and how they determined the practices they would later undertake as teachers. That is, within the rule structure of social systems such as teacher preparation programs, there is a lot of personal variation in the interpretation, enforcement, adoption, circumvention, and even active opposition of certain ideas and teaching strategies (Burns & Dietz, 2000) (in Bandura, 2001). Nespor (1987) concluded that beliefs are influential in determining how individuals organize and define tasks and are predictors of behavior. By examining the sources NPSST consult in making decisions about planning, I would like to identify the sources that pre-service teachers believe to be useful and which of those sources influence their planning decisions.

Brandi

Brandi consulted use of Tennessee's Next Generation Tools for Teaching Standards-Based Science CD and Standards documents, but attributed her planning decisions to Bloom's taxonomy (Bloom & Krathwohl, 1956). Brandi stated "I used the six levels of Bloom's taxonomy objective writing. I have that in a textbook and so I just used that to get ideas of what students should do so that I won't just pick from the first level, but get some more advanced ones also." It should be noted that Bloom's taxonomy is not referenced in the CD or within TPTE 353. When asked why she planned this way, Brandi said "I think maybe because I just like doing it this way." Brandi's statement that Bloom's taxonomy influenced her science lesson planning exhibits use of personal agency. Bandura claims that social structures are created by human activity, and sociostructural practices, in turn, impose constraints and provide enabling resources and opportunity structures for personal development and functioning (2001). By exercising "self-influence" (Bandura, 2001, p.15), Brandi operated proactively, not just reactively, to shape her understanding of the social system of education.

Initially, Brandi felt overwhelmed and intimidated by planning her science lesson using the CD. She was unable to access the hyperlinks to gain use of internet documents using her personal laptop and could not view page numbers. Brandi expressed "I felt as though I would never master lesson planning using this tool." Brandi was not able to access the Lesson Builder template so she used the Unit Builder template instead. She found the CD hard to navigate, struggled to remember how to complete certain parts of the Unit Builder, and attributed this in large part to being a novice in the education program. Brandi's feelings are typical of students entering a new field of study. When

most students enter their academic disciplines, they are unlikely to have well-developed theories or preconceptions about their field of study (Posner, Strike, Hewson, & Gertzog, 1982), they feel like strangers. However, many pre-service teachers seem themselves as insiders (Pajares, 1992), “the classrooms of colleges of education, and the people and practices in them, differ little from classrooms and people they have known for years” (p.323). As a novice, Brandi shared her experience using the CD as a resource to write a science lesson plan.

The CD was helpful in many ways, but could be more helpful to new teachers. Even though the CD contains a unit builder for novice teachers, I do not feel it is adequate in explaining to new teachers what it wants. It is also a fairly hard CD to navigate at times. I am still so new to the education world and so unfamiliar with education lingo (Brandi, First Guided Reflection, February 28, 2007).

After her first draft reflection, Brandi described that Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD (Audet & Jordan, 2007) was a source she consulted in writing her first science lesson plan and that several resources found on the CD were beneficial. Particularly, she stated

It’s definitely been useful as far as being able to click on the links to the Standards. The page that has all the different links to different science labs and activities was really nice. (Brandi, Semi-structured interview, April 4, 2007)

The framework page was a great tool. I used it multiple times throughout my lesson building to locate links or tools I could not find elsewhere. (Brandi, Semi-structured interview, April 4, 2007)

One thing I liked about each section of the Unit Builder was that it would say ‘Here, you need to write, blah, blah, blah under assessment. This is where you put...and it would just kind of give a little description. So, I liked that. (Brandi, Semi-structured interview, April, 4, 2007)

During the semester, Brandi only used the CD as a lesson planning resource once to write her science lesson plan. She expressed that with more practice “this CD will

become a helpful tool in my future lesson planning” but will not be used solely “I wouldn’t use the CD template to write lessons and stuff. I would almost rather sit with a word processor, and use this in another window to click on links and use some of the resources.”

While writing her science lesson plan for TPTE 353, Brandi used the lesson plan template and many of the resources found on the CD. Science reform documents and the Standards found within them were not sources that influenced her planning decisions, even though she claimed to have read all of the reform documents and inserted Standards into her lesson plan (Brandi, Final Guided Reflection, May 15, 2007). She explained, “I don’t really care about the standards, I know I need to. And I know they’re important because they are there for a reason. But I care more about getting the kids involved and making sure that they are learning” (Brandi, Semi-structured interview, April 4, 2007). She appears to have a rather sophisticated understanding of what teaching is all about. She designs her lessons through the lens of students’ themselves. The only source that influenced Brandi when making planning decisions, other than the lesson template and resources found on the CD, was Bloom’s taxonomy.

Chase

Chase explained that his planning decisions just come naturally to him, and that many of his decisions are influenced by the fact that he is a visual learner. He said

I myself am a visual learner so I think about the activity that I’m going to do and it helps me visually. It’s not really a visual thing but it is mental and visual I guess. And so that’s probably why I come up with the activity before I come up with the meat and potatoes of the rest of the lesson plan, just because I learn visually and hands-on (Chase, Semi-structured interview, April 11, 2007).

During the act of developing lesson plans, Chase described several sources he consulted. He read his Physics textbook to find a topic that “would be fun.” The Tennessee Curriculum Standards helped him to narrow his search for a topic “I used the state Standards to get the ball moving”. *Science For All Americans* was then used to supplement his knowledge of the subject. Next, he researched the topic “I read my texts on the subject of simple machines, and browsed the web and made several Google searches on simple and compound machines. By doing this, I gained insight on how other teachers have taught this subject” (Chase, First Guided Reflection, March 25, 2007). His roommate was also an inspiration for writing his lesson plan on simple machines. Chase presented a detailed perspective on science planning that went beyond filling in the required sections of a lesson template.

Although the Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD recommends that teachers consult the NSES, Tennessee Curriculum Standards, *Science for All Americans*, and *Benchmarks for Science Literacy*, Chase admitted to only reading the Tennessee Curriculum Standards and *Science for All Americans*. The other documents were used “only because I had to.” He described his preference for the state standards and SFAA “I used the state standards to get the ball moving. It gave me a place to start; it narrowed by search for a topic. After I was sure about my topic, I used SFAA to supplement my knowledge of the subject. The other standards I used, honestly, only because I had to” (Chase, Final Guided Reflection, March 25, 2007). He also explained why he chose not to read NSES and *Benchmarks for Science Literacy* “they seemed redundant after looking at the state standards and SFAA. I see the state standards as the main guideline I need to follow and these other standards

as supplemental material.” Chase was the only participant to share this view of Standards. His answer represents a more complex understanding of science Standards than his classmates and suggests a uniform set of science standards to guide science planning.

Bandura (2001) argues that people vary in the way they interpret, enforce, adopt and oppose the rule structures of social systems. In this case, the Standards presented in reform documents serve as rule structures of education system. These transactions involve a dynamic interplay between individuals and those who preside over the institutionalized operations of social systems (Bandura, 2001). Chase serves as an example of these transactions. He exhibited personal agency when he used the TN Curriculum Standards and SFAA as a guide to make decisions and chose not to use the other reform documents when making planning decisions. He also recognized the rules of institutions when he included all of the Standards in his lesson plan, even though some were included only “because he had to.”

Chase expressed that his thoughts on lesson planning and using the CD changed several times during the semester. After turning in the final draft of his first science lesson plan he wrote the following in a guided reflection, “I first thought of lesson plans as a place to list the ideas of the day, kind of an itinerary. After the CD was given to me, my mind became overwhelmed. I had no idea how intense lesson planning could be.” He went on to express how this view changed “the more I see and use the Next Generation CD, the more I like it. It really helps me fine tune lessons. With gathering standards from other resources, state standards and national standards, I have started to see the benefit of using this resource.” Chase liked the CD because it helped him

brainstorm, linked him to resources, provided valid information, and because the lesson template was labeled and organized (Chase, Final Guided Reflection, May 30, 2007).

Chase's answer demonstrates that he finds the Standards documents as meaningful in the planning process and indicates his intent to use the CD in future planning.

Laura

Laura read each science reform document linked to the CD lesson template and stated "every standard document played a part in the lesson I prepared using the CD."

She found several aspects of the CD to be beneficial "I looked at Web Quests. I was very interested in Web Quests because I was introduced to them last summer. It seems as though they are good since technology has really taken over the schools. I was glad to see them on the CD." She liked receiving extra material from the CD to supplement information found in her textbook, "everything is right there at your fingertips. You don't have to go searching all over to find the information when it is right there."

Tennessee's Next Generation Tools for Teaching Standards-Based Science CD was the source Laura consulted most in composing her first science lesson plan. "Now, every lesson I plan goes through checkpoint with the resources available on the CD. I use this resource to make sure the activity I am planning is meeting each standard effectively."

The sources Laura consulted when making planning decisions were the Next Generations Tools for Teaching Standards-Based Science CD, a textbook, and Standards found within the science reform documents found on the CD. She stated that the Standards are always in her mind when planning a lesson, "all in all, every standard

document played a part in the lesson I prepared using the CD” (Laura, Final Guided Reflection, May 14, 2007).

Hazel

Hazel consulted several sources in composing her first science lesson plan. She obtained Web Quests for student activities and Web Links to science content information from Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD. She used her college textbook to supplement her content knowledge. Hazel chose to read the Tennessee Curriculum Standards, the NSES, *Benchmarks for Science Literacy*, SFAA. She read all of them, “I was trying to get a grasp on what my options were. I read a lot under each Standard” (Hazel, Final Guided Reflection, June 1, 2007). The Tennessee Curriculum Standards and NSES guided her choices in what content to cover in her lesson “I found the NSES and state standards to make perfect sense and to be good guidelines to help me stay on track and focus on things that might be more important for the kids.” However, she didn’t find the *Benchmarks* and SFAA useful “they repeated themselves and maybe I don’t know how to apply them, but they seem kind of useless to me. I didn’t like those two.”

Initially, Hazel shared that she liked using the CD for lesson planning and thought it would be extremely useful in her future planning. She stated “I liked it because everything seemed important. Everything is pretty much there, if you can find it. Good resources to have that I might not have known to go look for.” Her favorite resources found on the CD were Web Quests, Web Links, Science Education Organizations, and the link to Reading and Writing across Content Areas. Hazel estimated that she could see

herself using this CD once or twice a week during her student teaching and in her future classroom.

Hazel also pointed to aspects of the CD that were not beneficial. She was never able to access the Lesson Builder. Hazel thought the Unit Builder was difficult to navigate. She found copying and pasting information within the lesson template distorted the template and couldn't easily be done. She also felt that the lesson templates required too much information, should be shorter and more concise. Hazel said, "I just don't like how or understand why I need to include all of the information from SFAA and *Benchmarks*. There just seems to be more information on here than is really necessary." During TPTE 353 Hazel expressed she was willing to do what it took to get good grades, but she does not see herself filling out every section and requirement of the CD when she is planning lessons for her own classroom. Hazel used personal agency to approach writing a science lesson and to using the lesson template found on the CD. To be an agent is to "intentionally make things happen by one's actions" (Bandura, 2001, p.2), an intention is a representation of a future course of action to be performed (Bandura, 2001). That is, in agentic transactions, people are producers as well as products of social systems. In this case the social system is the system of education.

Instead of accepting the template and all of its requirements, Hazel tried to understand if each of the requirements was useful to her as a future teacher. Bandura (2001) claims that people "figure out ways to circumvent physical and environmental constraints, redesign and construct environments to their liking, and create styles of behavior that enable them to realize desired outcomes" (p.15). Here, Hazel exhibited personal agency by exercising self-influence when adopting a new lesson plan template.

Karen

Karen explained that since this lesson plan was supposed to be a culturally relevant lesson plan, that she did not begin planning this lesson the same as she typically begins to plan. Instead of first consulting the Tennessee Curriculum Standards, she began by consulting a CD obtained by her professor that provided information on African American scientists and their accomplishments. Karen was trying to make sense of what she will be teaching rather than designing the lesson only for accountability purposes. She found a scientist who was the first to conduct research on cancer, this finding influenced her decision to plan a lesson on mitosis. Karen described “since I knew that this was supposed to tie a multicultural activity in my lesson plan I first began with the DMS CD with African American scientists so that I could build my lesson accordingly.” Karen also supplemented her lesson by consulting Tyson Tildon’s research on cell division, found on-line.

Karen’s typical planning process involved first consulting the Standards and then finding an appropriate activity. If she feels she does not understand the topic sufficiently, she uses a textbook to improve her content knowledge.

Throughout her guided reflections and interviews, Karen referred to her use of Project WILD (Council for Environmental Education, 1992) as a great resource. Project WILD is an interdisciplinary, supplementary conservation and environmental education program for educators, created to address Kindergarten through eighth grade science Standards. The Project WILD text was introduced to Karen in a previous science course. This text is not located on Tennessee’s Next Generation Tools for Teaching Standards-Based Science CD (Audet & Jordan, 2007). Karen stated,

But my Project WILD book I use a lot, in the sense like I know that mitosis might not be there. I find myself using the Project WILD book for younger grades more than I do for high school. I think I would probably use it more if I taught in younger grades because it matches the standards. But, I think they are still relevant for older students as well, even though Project Wild activities do not address standards found in grades 9-12. (Karen, Semi-structured interview, April 18, 2007)

If I cannot come up with the best activity, I will go on-line. Or I'll go and look in my Project WILD book or I'll ask people for an activity. (Karen, Semi-structured interview, April 18, 2007)

You're never too old for Project WILD activities. (Karen, Semi-structured interview, April 18, 2007)

Karen consulted several sources when planning her science lesson. She consulted the Tennessee Curriculum Standards, SFAA, information from Tyson Tildon's cancer research found on-line, a textbook, Project WILD, *Benchmarks for Science Literacy*, and the NSES. However, Karen's statements about Project WILD displayed her lack of understanding of matching high school science Standards with developmentally appropriate resources and activities.

Initially, Karen described how she liked using the CD for lesson planning "I liked the novice builder because it gave me cues on what to include in each section. It was also convenient that all the links for national and state science standards, and Benchmarks were included in hyperlinks." In her first guided reflection, Karen shared that the novice lesson plan template was especially helpful, "I liked the novice builder because it gave me cues on what to include in each section. I realized that not deleting these items while writing helped me revisit each section to make sure I had included all the details."

The CD was difficult for Karen to navigate until she found the concept map that illustrates the CD's framework. After having been shown the concept map Karen still

experienced frustration “sometimes I feel like I'm clicking and clicking and clicking but not going anywhere.” Karen decided to use the Unit Builder template when she was unable to locate the Lesson Builder template.

Karen’s use of the CD varied. She used the CD when designing the first draft of her first science lesson plan and when editing the final draft of her first science lesson plan. When her lesson plan was due for TPTE 353, she used the CD two or three times a week. During weeks when a lesson plan was not due in TPTE 353, Karen did not use the CD except for when planning a unit plan for another course. Then, she used the lesson plan template and applied it to another subject area. Karen described that she would definitely use the CD in her future planning, “Well, I'll be writing lessons everyday in my student teaching, so I think I would use it. I think I would have the template forever and just keep adding to it” (Karen, Semi-structured interview, April 18, 2007). Karen explained that she will use the CD in the future for the information it contains on inquiry and the 5E learning cycle (Karen, Semi-structured interview, April 18, 2007). She referred to using the CD as a planning tool during her student teaching and expressed interest in adding additional planning resources to her repertoire of science education resources.

Samantha

Samantha mentioned that her lesson planning process is very time-consuming. When planning a science lesson, Samantha consults the Tennessee Curriculum Standards, SFAA, *Benchmarks for Science Literacy*, and the NSES. She reads each of these

documents and chooses information to include in her lesson plan template. Samantha described Standards as being helpful to teachers,

Standards let the teacher know what is expected in each grade level and how each grade builds on content presented in previous grades. Teachers have a tool with these Standards to fill in missing knowledge, in case students did not get all the information in the previous years. (Samantha, First Guided Reflection, February 28, 2007)

Samantha, who is originally from Germany found the Standards documents to be important “since I am not familiar with the American system whatsoever, the standards have been most useful.” Her statements demonstrate that she uses Standards to gain an understanding of the science benchmarks students’ should have obtained prior to her lesson, and how she can best prepare them for their next steps in science. This answer represented a more complex understanding of using science benchmarks in planning, than her classmates’.

In her first guided reflection, Samantha described herself as being comforted and reassured when she found that the CD provided her with the national and state standards. Having access to each of these documents gave her confidence that her lessons would be appropriate, “at least the basic ideas will be covered in my lesson.” Samantha found the CD beneficial and easy to use, “first you get what you are supposed to teach and all you have to do is figure out the timing of when you want to do these things, in which sequence, and the details.” This was particularly meaningful to Samantha since she was not familiar with the American educational system and standards.

Although Samantha found the CD beneficial, she had a few complaints after using the CD. She was able to locate the Lesson Builder template but did not recognize the difference between the Lesson Builder and the Unit Builder template, so she chose to use

the Unit Builder template. Samantha was interested in locating state curriculum standards for Biology, honors, and AP classes but could not find them. She did not like that the lesson plan template was larger than the display screen on her computer “I did not like having to move the display left to right.” She had a problem with the advice provided in the novice lesson plan template “it says ‘Locate ALL of the standards. Copy and paste the information here.’ So I put everything there.” Samantha copied the entire NSES document and pasted it into her lesson plan, thus making her lesson plan over sixty pages long. She felt this portion of the template was, “confusing for foreigners”. Although the lesson template found on the CD is a helpful source for locating science reform documents it can be very confusing to novice pre-service teachers and causes frustration.

When planning her science lesson, Samantha inserted the recommended information into each portion of the lesson template. She used science education reform documents to understand students’ trajectories of learning, however, she exhibited a view of students that does not align with these documents, “teachers have a tool with these Standards to fill in missing knowledge, in case students did not get all the information in the previous years. (Samantha, First Guided Reflection, February 28, 2007). Here, Samantha demonstrates a teacher centered approach that views students as empty vessels and views the teacher as the center of knowledge, directing the learning process and controlling student’s access to information. Haney, Czerniak, and Lumpe (1996) argue that oftentimes teachers’ beliefs regarding learning are not aligned with the educational reform beliefs (such as those presented in science education reform documents);

therefore, reform efforts are short lived. This concern applies to Samantha. Even though Samantha is consulting science education reform documents, her beliefs tend to self-perpetuate, persevering even against contradictions presented in her teacher preparation program and science education reform documents.

Currently, Samantha uses the CD twice a week and can see herself using the CD as a lesson planning resource in the future unless she finds that another tool better meets her needs. In the semi-structured interview, Samantha stated, “if someone shows me another way of how to make lesson plans or a different tool and I feel that it is easier or more convenient for me, I might use the other one” (April 18, 2007). This statement exhibits Samantha’s personal agency, or intention to use lesson planning tools that are user friendly. Early in the semester, she explained her potential use of the CD “since I only have this tool, I will use it after I become comfortable using it.” After completing her final lesson plan Samantha shared that she would prefer reading the Standards in books instead of on the CD “if I have five books, I know which book to look in.” In the final interview she explained that she hasn’t explored all of the different characteristics of the CD and would like to further investigate its’ resources “I need to spend more time with the CD. I need to look at it and become more familiar.”

Each time she plans a lesson, whether for science or another subject, she also consults the internet. She conducts Google searches to see sample lessons that other teachers have created. Samantha visits the library to find content resources and pictures to use as visual aids. Visiting the library and conducting Google searches are not requirements of the TPTE 353 course. Samantha explained, “I’m a person that likes to

start looking on Google and Webpages. I like to go to libraries and look at pictures and pick out the nicest one, best scheduling, and put the lesson together. It is very time consuming but I wouldn't know how to do it differently" (Samantha, Semi-structured interview, April 18, 2007).

When asked why she plans this way, Samantha explained that this is just her approach. Samantha stated "I try to get as much information in as possible and filter out what is garbage and keep information that is important. I think it's a character thing." Samantha does not link her planning process to planning methods demonstrated in her science education course, instead she internalizes her process as a result of her character. The reform documents pre-service teachers found to be influential in the planning process are found in Table 4.

I present a cross-case analysis of my data in the following section.

Cross-Case Analysis

Research Question I Analysis

What processes do novice pre-service secondary science teachers pursue as they engage in lesson planning?

Participants described their lesson planning process in a guided reflection after writing the first draft of their first science lesson plan. Each participant described five or six steps. All participants mentioned four common steps. These steps were:

- Choose a topic
- Find a reference or resource for content information
- Consult the Standards

- Search for an activity

There was one extra step mentioned among the group, choosing an assessment. This step was mentioned by only four of the six participants. All TPTE 353 students were asked to create an assessment rubric for their first science lesson plan. Assessment was not given priority in the planning process of my participants. This indicates that my participants view teaching as a process of transmitting knowledge and of dispensing information through activities, rather than identifying students' learning needs, weaknesses and strengths and using them to craft and enrich instruction based on student assessment.

Two participants did not mention assessment in their initial description of their lesson planning process, however each of them included an assessment in both their draft and final lesson plans. This indicates that these novice pre-service teachers value assessment as a means of accountability, as pre-service teachers they were required to include an assessment in their lesson plan. Assessment was not mentioned to have informed their planning decisions. These findings suggest my participants possess a naïve understanding of how assessments of students learning can inform the practice of teaching and subsequent student learning.

While all six participants mentioned consulting the Standards as a common step in the lesson planning process, there were two different ways the Standards were used. Three participants designed their activity and lesson plan and then went to find Standards that matched their lesson plan. The remaining three participants consulted the Standards first to guide them in designing an activity and lesson. Findings suggest that all of my

participants viewed Standards as an attribute to be included in lesson plans, however the difference in their use suggests varying understandings of their value.

Consulting the national, state, and local standards before making planning decisions is an attribute of good teaching, recommended in science education reform documents (AAAS, 1993; NRC, 1996). These documents define the ideas and skills that students should learn, and provide a vision for achieving science literacy for all students (AAAS, 1993; NRC, 1996). Teachers who use the Standards when making planning decisions have a tool that informs them of developmentally appropriate content for their students and informs the design of assessment (Keeley, 2005). Science education reform documents not only guide choices of content, they also suggest appropriate pedagogy and provide common misconceptions students may have regarding new concepts (NRC, 1996). It follows that the three participants that first planned their lessons and then found Standards to match did not recognize the valuable attributes of Standards, that is they held a naïve understanding of how students learn and how the Standards can inform teachers of developmentally appropriate content. This naivety was exhibited by their choice not to include science education reform documents when making planning decisions.

Research Question II Analysis

Does novice pre-service secondary science teachers' planning during field placements correlate with the standards-based planning template introduced in TPTE 353 via standards-based science lesson planning software?

Each participant created a draft lesson plan using the novice lesson plan template found on Tennessee's Next Generation Tools for Teaching Standards-Based Science CD,

and then turned in a final draft of the same lesson plan. Both lesson plans were created using the same lesson plan template. Participants were taught to use this template in TPTE 353. These lesson plans were examined to see if novice pre-service secondary science teachers' planning during a field placement correlated with the science education reform-based planning template advocated in an education course.

Participants entered information into each section of the lesson plan template, excluding three sections. There were three common sections into which participants chose not to enter information. Those sections were:

- Curriculum Integrations
- Lab Safety
- Standardized Test Item Generator

Curriculum Integrations is a portion of the template that allows teachers to find curriculum standards from other subjects that are simultaneously taught during the science lesson. None of the participants chose to look for Standards from other subjects that aligned with their science lessons. The Curriculum Integrations portion of the lesson template was left blank on all of my participants' draft and final lesson plans. As novice pre-service teachers, my participants focused solely on the science content to be taught in one lesson.

When participants turned in their draft lesson plans, only two participants entered any information into the Lab Safety section of the lesson template. Once participants polished their draft lesson plan and turned in their final lesson plan, three students had chosen to include Lab Safety information in their lesson plans. Students in TPTE 353 were required to include information from reform documents in their lesson plans.

Students were not required to include Lab Safety procedures. The lack of Lab Safety procedures included in final lesson plans may indicate a naivety of their importance in science education.

The Standardized Test Item Generator section of the lesson template asks participants to locate typical Standardized test questions associated with the content, using the search links provided by the CD. Only one participant chose to look for Standardized test questions that might be asked of their students during Standardized testing.

Research Question III Analysis

What sources do novice pre-service secondary science teachers consult in making decisions about planning and which of those sources influence their planning decisions?

The lesson template provided by Tennessee's Next Generation Tools for Teaching Standards-Based Science CD suggests that teachers consult four science reform documents:

- *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993)
- *Science for All Americans* (AAAS, 1989)
- *Tennessee Curriculum Standards* (Tennessee Department of Education, 2007)
- *National Science Education Standards* (National Research Council, 1996)
- *Tennessee's Next Generation Tools for Teaching Standards-Based Science*, (Audet & Jordan, 2007)

Participants were asked to consult these documents as well as Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, and to use the information that each provides in planning their first science lesson plans. Here I present a cross-case analysis of the science education reform documents novice pre-service secondary science teachers consulted when making planning decisions regarding their first science lesson plan.

All participants chose to consult the TN Curriculum Standards. Five of the six participants expressed that these Standards influenced their lesson planning. Five of the six participants consulted *Benchmarks for Science Literacy*, but only two participants found them beneficial. Five of the six participants chose to consult SFAA, but only two found them to be influential in the planning process. Five of the six participants chose to consult the NSES, but only half of the participants found that these Standards influenced their decisions when planning. These findings suggest that the lesson template provided by the CD requires pre-service teachers to insert information from science education reform documents that does not influence their planning decisions. This requirement helps teachers to meet the requirements of school administrators but does not address the needs of teachers to learn about the recommendations put forward by science education reform documents, in a reflective manner.

The task must be structured in a way so that it prompts teachers to reflect or to find science education reform documents meaningful. More emphasis needs to be placed on the valuable information found within science education reform documents for science educators. Currently, novice pre-service teachers are copying and pasting information into their lesson plans that does not help them plan science instruction, this is an indicator

that my participants are simply complying with university procedures and hold a naïve understanding of what it means to design a lesson that is instructionally meaningful to students.

Several additional themes emerged as the data were analyzed. The themes are presented below.

Themes

Choice of Lesson Planning Process

Five of the six participants stated that they planned in the way they did either because of their own experience as a student or because of their individual approach to teaching. Brandi, Chase, Hazel, and Samantha held similar conceptions. Each of them expressed that the way they planned was unique to them. For example,

“I think maybe because I just like doing it (planning this way).” (Brandi, Semi-structured Interview, April 4, 2007)

“It’s just natural. It’s just the way it is I guess.” (Chase, Semi-structured Interview, April 11, 2007)

Probably because it is unorganized and that’s the way I am. Because it is haphazard and something good will come out of it at some point. (Hazel, Semi-structured Interview, April 11, 2007)

“That’s just my approach. Something sparks my mind. I think it’s a character thing.” (Samantha, Semi-structured Interview, April 18, 2007)

When asked why they plan the way they do, only two of my participants stated that they planned the way they did in response to Standards and assessment. Both of them did this to meet accountability requirements.

“As far as picking standards first, it is because it has been stressed now in the education system that you have to meet the required standards. So, I look at the standards and see what way I can use my creativity to get my students to want to know the information.” (Laura, Semi-structured Interview, April 4, 2007)

“I don’t want to cover something that is not in the standards.” (Karen, Semi-structured Interview, April 18, 2007)

Neither of them used the Standards to see where their lesson might fit into the curriculum for the grade level or to assess if students were on developmentally appropriate levels of understanding. Participants’ use of Standards in planning did not reflect a mature understanding of their value as a teaching resource.

Three of my participants reflected that their planning decisions were based on their own experience as students. For example,

“I plan this way just because I learn visually or through hands-on activities.” (Chase, Semi-structured Interview, April 11, 2007)

Now the rest of the planning, I don’t know why I plan my lessons that way. I know that most of my lessons are very hands-on, cooperative learning and games, because of me being a high school student just four years ago. I realize that those are the things that kept me interested in my classes. I want the same for my students. (Laura, Semi-structured Interview, April 4, 2007)

“As I plan activities, I have something in the back of my mind from my experience.” (Samantha, Semi-structured Interview, April 18, 2007)

The above quotes indicate the lack of sophistication of my participants’ lesson planning. These quotes suggest that my participants’ agency is influenced by their own experience as learners, rather than by best practice or reform recommendations. As novice pre-service secondary science teachers writing their first science lesson plan, my participants do not see their lessons as nested in a larger system of education. They do not make connections between curriculum, pedagogy, assessment, and planning. When asked why they plan the way they do, only two participants mentioned a science education reform document to have influenced the planning process for accountability.

Both of these participants used science education reform documents for accountability purposes, neither of them wanted to teach a concept that was not found in the Standards.

Teacher preparation programs can ill afford to ignore the entering beliefs of pre-service teachers (Pajares, 1992), especially beliefs on such topics as science education reform, NOS, and the importance of assessment. It follows that “investigations examining teacher belief structures in the context of science reform are needed to guide current science reform into lasting change” (Haney, Czerniak, & Lumpe, 1996, p.972). As reflected in their planning process, my participants do not hold strong beliefs of the importance of science education reform documents.

Several researchers on reform support the notion that teacher beliefs are precursors to change and that the teacher is the crucial change agent in paving the way to reform (Ajzen & Fishbein, 1980; Crawley & Koballa, 1992; Cuban, 1979; Fullan & Miles, 1992; Haney et al., 1996; Pajares, 1992). Pre-service science teacher education programs must develop and challenge pre-service teachers’ prior conceptions of the nature of science (NOS), the importance of assessment, and the need for science education reform. Asking pre-service science teachers to follow the guidelines of a CD does require them to exhibit an understanding of the applicability of its content. The CD could be made more influential if pre-service teachers were asked to reflect on their planning process, information found within science education reform documents, and their potential future steps in planning.

I present my participants’ conceptions of the important components of lesson planning in the following section.

Important Components of Lesson Planning

Three of the six participants stated that the assessment is the most important part of a lesson plan. This is interesting to note because assessment was not given priority when participants listed the steps of their planning process. When I asked them what they thought was the most important component of lesson planning, one participant stated that the procedure is the most important part of the lesson plan, and two participants stated that the objectives were most important.

“Probably coming up with an effective assessment, making sure that students are understanding.” (Brandi, Semi-structured interview, April 4, 2007)

“I think the most important component of a lesson plan is making sure that your assessment is valid and ties in with the activities.” (Karen, First Guided Reflection, April 2, 2007)

Although my participants did not reference science education reform documents as having an influence on their lesson planning process, three of the six participants exhibited a sophisticated understanding of lesson planning by placing importance on student assessment. This reflects that these participants plan instruction based on the outcome of student assessments.

The remaining three participants placed value on the procedure and objectives in a lesson plan. These comments reflect Pigge and Marso’s (1986) findings that entering teacher candidates are most anxious about their lesson planning skills and the procedure of their instruction. This finding was consistent my research findings. My participants designed lessons with students’ learning needs in mind, however the features of inquiry were not mentioned when I asked them to name the most important part of a lesson plan.

I present my participants' change in their lesson planning process in the following section.

Change in Lesson Planning Process

Three of the six participants stated that over the spring semester their process of lesson planning had changed since the beginning of the semester. The lesson template found on the CD helped them to organize their ideas for instruction and made the Standards documents more accessible. These participants changed their procedure to reflect science education reform document recommendations and use of Standards.

“My ideas about lesson planning really have changed. I now see the importance of having my thoughts and activities organized into a lesson plan. Five months ago I probably would have said that lesson plans are unnecessary. Now I know that they are very important and necessary.” (Brandi, First Guided Reflection, April 29, 2007)

“I believe that my focus on lesson planning has changed in the aspect of learning about the Standards, especially using *Science for All Americans*.” (Chase, Final Guided Reflection, May 30, 2007)

“Yes. Lesson planning became easier and I got more familiar with the links given on the CD. I would change my procedure by looking at the Standards first and then fill in my lesson.” (Samantha, Final Guided Reflection, May 3, 2007)

When asked if their lesson planning process had changed during TPTE 353, only half of my participants explained their process had changed. Three of the six participants stated that their lesson planning process had remained the same throughout the semester.

“My lesson planning has not changed since the rough draft.” (Lauren, Final Guided Reflection, May 14, 2007)

“The process has not changed too much. I am using the CD you gave us though.” (Hazel, Final Guided Reflection, June 1, 2007)

Laura did not change her lesson planning process, however she already planned according to the Standards. Brandi and Hazel shared that their lesson planning process

did not change, neither did their use of science education reform documents. Brandi and Hazel continued to copy and paste Standards into their lesson plans without seeing the information as influential. The remaining three participants, Samantha, Chase, and Karen, changed their procedure to reflect science education reform document recommendations and Standards. For both current national and statewide reform efforts in the United States to avoid the mistakes associated with previous science reform, it is necessary to identify potential barriers to change (Haney et al., 1996; Howe, Blosser, Helgeson, & Warren, 1990). Further studies on these participants could identify such barriers and inform science education reform efforts.

I present my participants' conceptions of the influence of Standards documents in the following section.

Influence of Standards Documents

The lesson template provided in Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007), emphasized four science education reform documents, *Benchmarks* (American Association for the Advancement of Science, 1993), *Science for All Americans* (American Association for the Advancement of Science, 1990), Tennessee Curriculum Standards (Tennessee Department of Education, 2007), and National Science Education Standards (NSES) (National Research Council, 1996). Participants stated which of these documents influenced their planning decisions.

Influential Standards Documents

I used the State Standards to get the ball moving. It gave me a place to start; it narrowed my search for a topic. After I was sure about my topic, I used the Science for All Americans to supplement my knowledge of the subject. The other

standards I used, honestly, only because I had to. (Chase, Final Guided Reflection, May 30, 2007)

Having the state standards available to me was the most helpful to me because I am held more accountable for them. From reading all the standards, I did get an understanding of what information needs to be emphasized, so the students will be prepared for the next lesson. I also used the standards to receive more information on my subject that was not in the textbooks, especially the historical view of the subject. (Laura, Final Guided Reflection, May 14, 2007)

“I used the NSES and the State standards to somewhat help guide what I needed to make sure I cover, and not just ramble.” (Hazel, Final Guided Reflection, June 1, 2007)

“Benchmarks for Science Literacy. I like to have a list of what students should know by the end of a specific grade. It gives me a goal to work towards.” (Samantha, Final Guided Reflection, May 3, 2007)

Five of my participants found the Tennessee Curriculum Standards to influence their lesson planning decisions. They used these Standards to guide their lessons and understood that they would be held accountable for following the curriculum guidelines contained in this document. The second most influential document that influenced my participants planning was NSES (NRC, 1996). These Standards were used in the same manner in which the Tennessee Curriculum Standards were used, to choose a topic and better understand the information that needs to be emphasized at each grade level.

Although participants were introduced to the NSES (NRC, 1996) and Tennessee Curriculum Standards in TPTE 353, they limited their use to choosing a topic and deciding what information to include in their science lesson plan. Participants did not consult the NSES to learn common misconceptions among students on specific topics, nor did they use the TN Curriculum Standards to examine the Standards taught at various grade levels. They did not see that these processes could inform their planning, help them assess student knowledge, or prepare students for the next grade level.

Only two participants found the *SFAA* and *Benchmarks* to influence their planning decisions. *SFAA* was used to improve content knowledge on the topic of their lesson plans by referencing it for background information, and the *Benchmarks* were used to inform them of the content goals for each grade level. Both of these documents were used in an appropriate manner, however the majority of my participants did not view them as useful. The four participants that did not acknowledge their need to improve content knowledge and to understand the curriculum goals set forth for each grade level in science education reform documents did not use these resources to their full potential. They expressed that the only reason they included portions of these documents in their lesson plans was because it was a requirement of the lesson plan template used in TPTE 353.

Standards Documents Were Not Influential

Although the TPTE 353 course required participants to use the same lesson template and asked that they consult four science education reform documents, participants' use of the documents varied. Brandi was the most extreme. She did not find the Standards documents to influence her lesson planning in any way, "the Standards really had no influence on what I wanted my lesson to be." In her final guided reflection she confirmed this statement by sharing that her lesson planning process did not change during the semester. Brandi did not believe that critical thinking and problem solving were strategies that could be taught through Standards, "I feel that if planning becomes dependent on the Standards, students are going to miss out on a lot of important things like critical thinking and problem solving." This misconception prevented Brandi from

using science education reform documents to inform her planning. Beliefs such as these are barriers to science education reform.

Chase found Tennessee Curriculum Standards and SFAA to influence his planning, but viewed the NSES and *Benchmarks* only as supplemental resources, “they seemed to be redundant after looking at the TN Standards and the SFAA. I chose not to read the NSES and the *Benchmarks*.” Hazel held similar opinions about science education reform documents at the end of TPTE 353, “NSES and state Standards were helpful. The others were a little confusing and redundant. I am sure they are useful, I just have not figured out how.”

Karen never provided a statement to support her use of SFAA or the *Benchmarks* or their influence on her planning decisions. She only commented on the value of state Standards, “I like the state Standards the most because they are clear and to the point.” It appears that my participants were not aware of the many benefits available to teachers through each of the science education reform documents. They were aware of accountability measures and used the NSES and Tennessee Curriculum Standards to help them meet this requirement. Once pre-service teachers have met the need of planning with Standards in mind, more time should be spent on broadening their viewpoint of lesson planning. These findings suggest that my participants view teachers simply as planners of activities and persons who assign grades. They do not see the need to draw on learning theory to support their investigations and analyses of student learning and planning for instruction.

Discussion

These findings demonstrate that novice pre-service teachers do not find the science education reform documents linked to the Next Generations CD to be equally useful or informative of their lesson planning practices. These differences reflect the agency that participants used while making planning decisions, as well as their lack of understanding of science education reform documents or how they were asked to use the CD. Haney, Czerniak, & Lumpe's findings suggest that teacher training should pay particular attention to the attitudes teachers have toward reform recommendations before alterations of the control factors (such as providing curriculum materials, Standards, and reform documents) are expected to lead to lasting changes in classroom practice (1996). It was therefore concluded it is unlikely that top-down, teacher-proof models of science inservice experiences would be successful. I advocate that novice pre-service teachers be introduced to the valuable attributes of science education reform documents, learn to discern their differences, and be allowed to exhibit autonomy when choosing which of the four reform documents to consult when planning, before they are to expected to produce lesson plans.

I present my participants' perception of using Tennessee's Next Generation Tools for Teaching Standards-Based Science CD in the following section.

Strengths in Using Tennessee's Next Generation Standards-Based Science CD

All participants stated that the CD was beneficial to them in lesson planning. Six participants found access to Standards beneficial. Laura described this feature well when she said, "everything (Standards and resources) is right at your fingertips. You don't have to go searching all over to find the information when it is right there. It is very

friendly once you know how to use it” (Laura, Semi-structured Interview, April 4, 2007).

The CD even helped Laura to understand the benefits of Standards and helped her analyze her job as a teacher. Laura stated,

Using the CD has made the idea of using standards as being the number one thing in lesson planning instead of finding creative ways of teaching a lesson. So now, Standards are always in my mind when planning a lesson. Every lesson I plan I now plan with the resources available on the CD. (Laura, Final Guided Reflection, May 14, 2007)

Samantha was calmed by how easily the Standards could be accessed using the CD, “the idea of having all the national and state Standards only a click away is very comforting and reassuring that at least the basic ideas are covered in my lesson” (Samantha, First Guided Reflection, March 25, 2007). Samantha went on to say, “with this CD, lesson planning is easy.” For novice pre-service secondary science teachers the CD provides them with an advantage. At this early stage in their education program, pre-service teachers do not have a large repertoire of science education resources to consult when planning their first lessons. The CD meets this need of novice pre-service teachers by providing them with a variety of resources with which to plan lessons.

Among the many resources on the CD are links to science education reform documents, sample lesson plans, sample Web Quests, and numerous science education Web Links. Five participants stated that the web links and Web Quests were beneficial to them when making planning decisions. Hazel expressed an interest in the resources found on the CD even though she only found two science education reform documents to have influenced her planning. She used a Web Quest as the activity in her lesson plan, “I liked the CD because everything that seemed important was there. Good resources to

have that I might not have known to go look for” (Hazel, Semi-structured Interview, April 11, 2007).

Another benefit of using the CD described among my participants was the novice lesson plan template found on the CD. While the expert lesson plan template provides large blank spaces in which teachers insert ideas, standards, and assessments, the novice lesson template provides prompts to assist pre-service teachers in the lesson planning process. Brandi shared, “one thing I like about it is that in each section of the lesson template is says “Here, you need to write...”. I liked that” (Brandi, Semi-structured Interview, April 4, 2007). Chase found this template helped him appreciate the value of writing lesson plans, “I have started to see the benefit of using this resource. The template has everything labeled and well laid out” (Chase, Final Guided Reflection, May 30, 2007). Karen liked having the lesson plan format because of the helpful prompts, “I liked the novice builder because it gave me cues on what to include in each section. I realized that not deleting those items while writing helped me revisit each section to make sure I had included all the details” (Karen, First Guided Reflection, April 2, 2007).

This data suggests that novice pre-service teachers benefit from a lesson template that provides them with detailed prompts as they make planning decisions and links them to science education reform documents. As pre-service teachers enter the field of education, they can often feel like outsiders (Pajares, 1992), my participants found the lesson template made them feel comforted. These findings also suggest that pre-service teachers benefit from being exposed to samples of teachers’ work, including lesson plans and Web Quest. These samples give pre-service teachers an idea of what a science lesson

plan should contain and motivate them to incorporate reform-based strategies in to their lessons.

The Next Generation Tools for Teaching Standards-Based Science CD was used by my participants as a tool in writing their first science lesson plan. Each of my participants found links on the CD that helped them in making planning decisions and provided them with needed resources. The CD is a helpful tool in introducing novice pre-service secondary science teachers to writing science lesson plans. An important attribute of the CD is the emphasis placed on Standards and how easily pre-service teachers can locate the Standards using the CD. The resources and template located on the CD are appreciated and needed by novice pre-service secondary science teachers who are beginning to collect a repertoire of lesson planning aids.

Technical Challenges of Using Tennessee's Next Generation Tools for Teaching Standards-Based Science CD

Although each of the participants stated that the CD was beneficial, many additionally stated that the CD was challenging. Participants expressed different frustrations with learning to access and navigate the resources found on the CD. As my participants began to first explore the CD and its contents, several frustrations were shared. Laura expressed these frustrations, "Where should I begin? Lets begin with frustration. My first time using the CD was mind boggling with frustration. Even though I had the CD layout I was still confused." First Guided Reflection, March 3, 2007). When Laura shared this, she had already received one class session of training and had written a draft of her first science lesson plan, using the CD. After her initial experience, Laura's opinion of the CD was negative. Chase agreed, he described the CD as "challenging"

Chase, First Guided Reflection, March 25, 2007). Samantha was the participant whose native language was German, she shared “the getting from one page to another and to other folders for copying/pasting information was annoying. The page format was inconvenient since the template was too big for my screen and not all the info inserted could be seen on the computer screen” (Samantha, First Guided Reflection, March 25, 2007). Navigating the CD to access various resources was found to be difficult, as well as copying/ pasting information into the lesson plan template.

Laura provided a suggestion, “my first use of the CD was very overwhelming. Training must be done to have this product succeed in the science field. The CD is great, but only if you know how to use it” (Laura, First Guided Reflection, May 3, 2007). To improve the effectiveness of Tennessee’s Next Generations Tools for Teaching Standards-Based Science CD (Audet & Jordan, 2007) the comments of novice pre-service secondary science teachers should be used to make important changes in structure and training. Pre-service teachers need specific training on navigating the CD. Without this training, pre-service teachers will not be able to use the CD to its full potential as a lesson planning resource. This would be a travesty as this is the only resource that directly links novice pre-service teachers to four science education reform documents at once. Without exposure to these reform documents and Standards, it is less likely that pre-service teachers will become change agents for reform.

Summary of Findings

A review of the data provided in this chapter for the six novice pre-service secondary science teacher case studies suggests the following key findings:

1. Regarding research question one:
 - a. The participants included four common steps in their lesson planning process.
 - i. Choose a topic
 - ii. Find a reference or resource for content information
 - iii. Consult the Standards
 - iv. Search for an activity
 - b. Assessment was mentioned as a step in the lesson planning process by four of the six participants.
 - c. The participants used the Standards documents in two different ways.
 - i. Three participants designed their activity and lesson plan and then went to find Standards that matched their lesson plan.
 - ii. The remaining three participants consulted the Standards first to guide them in designing an activity and lesson.
2. Regarding research question two:
 - a. Each participant created a draft and final science lesson plan using the novice lesson plan template found on Tennessee's Next Generation Tools for Teaching Standards-Based Science CD.
 - b. Participants chose not to enter information into three common sections of the lesson plan template.
 - i. Participants chose not to look for Standards from other subjects that aligned with their science lessons.
 - ii. Only three participants chose to include Lab Safety information in their lesson plans.
 - iii. Only one participant chose to look for Standardized test questions associated with the content of their science lesson plan.
3. Regarding research question three:
 - a. All participants chose to consult the Tennessee Curriculum Standards (Tennessee Department of Education, 2007).
 - b. Five of the six participants expressed that the Tennessee Curriculum Standards influenced their lesson planning decisions.

- c. Five of the six participants consulted *Benchmarks for Science Literacy* (AAAS, 1993), but only two participants found them influential.
- d. Five of the six participants chose to consult *Science For All Americans* (AAAS, 1993), but only two found them to be influential in the planning process.
- e. Five of the six participants chose to consult the *National Science Education Standards* (NRC, 1996), but only half of the participants found that these Standards influenced their decisions when planning.
- f. Participants did not find all of the science education reform documents to influence their decision making when designing their first science lesson plan.

CHAPTER V: CONCLUSIONS, DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

This chapter presents conclusions and lessons learned from the case studies, implications for practice, and recommendations for future research. The chapter is organized into five sections:

- 1) Purpose of the Study
- 2) Conclusions
- 3) Discussion
- 4) Implications for Practice
- 5) Recommendations for Research

Purpose of the Study

The purpose of this study was to empirically understand how novice pre-service secondary science teachers' conceptions reinforce or compete with essential features of reform-based lesson planning. Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4 (Jordan & Audet, 2007) was used to provide pre-service teachers with a science lesson template and lesson planning resources. An assumption of the researcher was that this study would provide links between science teacher preparation and action as related to planning instruction. A review of the participants' process when planning can be found in Table 4.

Table 4. Lesson Planning Processes of Novice Pre-service Secondary Science Teacher (NPSST).

	Brandi	Chase	Laura	Hazel	Karen	Samantha
# of Previous Courses that Taught Lesson Planning	0	2	3	2	2	0
Step 1	Choose Topic	Choose Topic	Choose TN Standards	Choose Topic	DMS CD (culturally relevant resource)	Choose Topic
Step 2	Brainstorm ideas	Browse textbooks to research the topic	Design a project to engage students with the Standards	Find information in a textbook for students to use as a resource	Find a source for content information (Ex: Tyson Tildon cancer research)	Consult TN Curriculum Standards and NSES to see what needs to be taught at that level
Step 3	Design an activity for the lesson	Conduct a Google search on the topic and look for supplemental information in textbooks	Sequence the steps of the lesson. (Ex: the student will..., the teacher will...	Find Standards to match to the lesson	Consult state Standards before planning activity	Create a list of materials

Table 4, cont.

	Brandi	Chase	Laura	Hazel	Karen	Samantha
# of Previous Courses that Taught Lesson Planning	0	2	3	2	2	0
Step 4	Choose state Standards that will match the activity	Search on-line to see how other teachers have taught this subject	Decide how to establish set, how to engage students as the lesson begins	Search on-line for activities	Plan an activity that will support the Standards	Determine how much time is needed for each portion of the lesson
Step 5	Choose assessment	Design an activities such as worksheets, demonstrations, and verbal discussions	Write the objectives or choose assessment	Choose assessment	Choose assessment	Use TN Next Generations CD to construct the lesson plan
Step 6		Use TN Next Generations CD to align lesson with TN Standards, NSES, Benchmarks, and SFAA	Write the objectives or choose assessment			

Conclusions

None of the participants had experience writing lesson plans using Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4, prior to TPTE 353. Practice using the CD generally changed participants' views of the CD over the spring semester. Initially, participants were overwhelmed by all of the resources provided and found navigation difficult. In the following section I present themes that emerged through analyzing data in regards to each research question.

Change in the Lesson Planning Process

The TPTE 353 course positively influenced the participants' planning procedures because it made them comfortable with the planning process. Brandi's process of lesson planning became less challenging. At first she was overwhelmed and now feels more comfortable writing lesson plans. Chase shared that he still does not understand how a lesson plan can be accomplished efficiently, but that his focus on lesson planning has changed in the aspect of learning about Standards. He found *Science for All Americans* to be a needed resource that reminded him of scientific aspects which he had forgotten. Laura did not change her lesson planning process over the semester but now views using Standards as her number one priority when planning lessons. Prior to TPTE 353, she did not consider the Standards when writing lesson plans. Hazel also did not change her lesson planning process over the semester but values using the CD as an organizational tool. Prior to TPTE 353, she did not use a lesson template or any other organization tool when planning. Karen did not change her planning process but now uses the CD to guide her through the 5E Learning Cycle of lesson planning. Use of the CD introduced her to

this lesson plan model that is most appropriate for science instruction. Samantha stated that her lesson planning process now includes consulting the Tennessee Curriculum Standards. This was not a step she included in lesson planning prior to the TPTE 353 course.

Use of Standards-Based Lesson Template

The lesson template introduced in TPTE 353 benefited participants. Brandi and Karen learned to create lesson plans with more detail. Chase shared that the lesson template helps him to finalize his exact thoughts. All participants appreciated the detailed questions found on the novice Unit Builder template. The novice Unit Builder template can be found in Appendix G. A common frustration with the lesson template was that participants were unable to locate the Lesson Builder template and found it difficult to copy and paste information into the template. Brandi was intimidated by the CD upon first encounter but became increasingly comfortable using it with practice. Chase was first overwhelmed but now likes the CD the more he uses it. After the course, all participants had plans of using the CD in future planning.

Change in Sources and Influences

All participants accessed the science reform documents suggested on the lesson template and included information from each document in their final lesson plan. However, participants varied in the extent to which they found each of the science education reform documents influential. Each participant shared which of the four science education reform documents influenced their planning decisions and which of the four had no impact on planning decision-making. Brandi consulted all four reform documents but shared that they did not influence any of her planning decisions. Chase

avored TN Curriculum Standards and *Science for All Americans*. Both of these documents influenced his planning decisions. Laura read all of the reform documents and felt they were each influential in her planning. Hazel used the Tennessee Curriculum Standards and the NSES in her planning but found *Science for All Americans* and *Benchmarks for Science Literacy* to be confusing and redundant. Karen used each of the reform documents as a resource but favored the NSES and *Benchmarks for Science Literacy*. Samantha created a project for her lesson plan and then attempted to fit the Standards into her lesson. She expressed that next time she would like the Standards documents to influence her planning decisions more than they did for this science lesson.

Discussion

The results and conclusions of this research study offer valuable information for the current science education reform movement. This study supports the body of research that asserts that teacher beliefs have a critical impact on planning for instruction and future classroom behavior (Battista, 1994; Cuban, 1979; Fullan & Miles, 1992; Haney et al., 1996; Pajares, 1992). Pajares (1992) states that research into teachers' beliefs can inform educational practice and teacher preparation in ways that prevailing research agendas have not. Moreover, teacher beliefs are the best indicators of teachers' planning, decision-making, and subsequent classroom behavior. The research I present promises to inform discussions surrounding both pre-service teacher education and science education. If we are to truly enact science education reforms, developing a better understanding into pre-service science teachers' conceptions of lesson planning and use of science education reform documents in lesson planning is essential.

Since the mid-1980s, research on teaching and teacher education has shifted from a focus on behaviors to a focus on cognition (Richardson, 1996) recognizing that teachers' beliefs, ways of understanding, and ways of thinking are vital components of their teaching practice (Clark & Peterson, 1986; Nespor, 1987). With this shift, the methodologies and approaches employed by researchers in this field have also gradually shifted toward qualitative methodologies, including use of semi-structured interviews. In this study I transcribed and analyzed semi-structured interviews, guided reflections, and lesson plans to understand the nature of novice pre-service secondary science teachers' thinking and processes when planning science instruction. This analysis also presented novice pre-service secondary science teachers' views on science reform documents.

Assessing teachers' beliefs about various dimensions of science education has become an important research topic in the field of science education (Irez, 2007). The purpose of this study was not only to focus on the lesson planning processes of novice pre-service secondary science teachers, but also to understand their use of science education reform documents. Findings suggest that teacher preparation programs should pay particular attention to the opinions and attitudes teachers develop toward each of these documents during initial exposure, before the use of each document can be expected to lead to lasting reform in science education.

Social cognitive theory subscribes to a model of personal agency (Bandura, 2001). The core features of personal agency enable people to play a part in their self-development, adaptation, and self-renewal with changing time while recognizing that an intention is a representation of a future course of action to be performed. Among the mechanisms of personal agency, "none is more central or pervasive than people's beliefs

in their capability to exercise some measure of control over their own functioning and over environmental events” (Bandura, 2001, p.10). In this study, novice pre-service teachers exhibited personal agency through their decision-making when writing lesson plans and through their varying use of science education reform documents.

Planning Science Instruction

Participants described their planning sequences using two distinct approaches: (1) designing the activity or other sections, then choosing corresponding Standards and objectives, and (2) working first with objectives and standards before considering the activity. Findings suggest that all of my participants viewed Standards as an attribute to be included in lesson plans, however the difference in their use suggests varying understandings of their value. My conjecture is that more time and emphasis needs to be placed on the role of science education reform documents in science education and the guidance these documents provide for science educators before students are ready to plan science instruction. Findings also suggest that each participant held unique intentions of how these documents would be used and the degree to which they would influence planning decisions. Novice pre-service teachers’ beliefs about lesson planning must be taken into account in teacher preparation programs. Pre-service teachers are the change agents that will be shaping the future of science education.

This research can be compared and contrasted to studies conducted by Clark & Yinger, 1979; Merriman, 1976; Strangis, Pringle & Knopf, 2006, described in Chapter 2. Strangis, Pringle, & Knopf (2006) also found student responses fell between two approaches to lesson planning, however student responses fell equally between two categories: planning activities first, and consulting Standards second. My findings were

similar in that participants' planning processes followed the same two patterns of consulting Standards. Clark & Yinger (1979) found that objectives are seldom the starting point for a lesson. Instead, teachers plan around their students and around activities. My findings suggest that novice pre-service teachers do not plan around their students needs. However choosing activities for lesson plans is a step that is given priority in the planning process. Merriman (1976) also concluded that teachers perceived the determining of students' needs to be the most important area and considered it first when planning. Interestingly, in my study, novice pre-service secondary science teachers rarely mentioned students' needs or used assessments of student strengths and weaknesses to guide planning. Although participants were not in a classroom setting, the lesson plans they were preparing were to be used with school aged children. Assessment was not mentioned to have informed their planning decisions. These findings suggest my participants possess a naïve understanding of how assessments of students learning can inform the practice of teaching.

Participants arrived at a final lesson plan via varying routes. Students began planning at different places in the planning process. That is, participants decided if they would begin their planning process by first examining Standards, first examining available resources, first creating an activity, etc. Moreover, through their levels of comfort with the different sections of the lesson plan template, students began planning at different places in the process. Findings from this study were consistent with the findings of Sanchez and Valcarcel (1999) and Strangis et al. (2006) who also found that the majority of participants began lesson planning by thinking of the content and Standards. While writing their first science lesson plans, the novice pre-service teachers held a

teacher-centered perception of teaching. Participants focused on listing Standards in their lesson plans for their own accountability measures and making sure they had enough resources to provide students with accurate content information. At this stage in their development as teachers, participants view students as empty vessels. Participants do not yet understand the need for differentiation of instruction or how assessment can be used to guide instruction. Participants were able to fill in the various segments of the lesson template, however they did not fully comprehend their value or how each portion of a lesson plan is related to and dependent on other portions.

Standards-Based Planning

All of the six participants used the standards-based lesson template and stated that they consulted two or more of the reform documents suggested by the template. Consulting the Standards before planning the assessment, activity, and objectives is the lesson planning process suggested by NSES (NRC, 1996). Participants in TPTE 353 were encouraged to consult these documents to construct their understanding of science content. The standards-based template on the CD and my personal instruction used in TPTE 353 made this point clear to most participants, except for Brandi. Laura stated that the standards-based lesson plan template made her aware of how she was becoming accountable for meeting both Tennessee Curriculum Standards and NSES. Only one of the participants, Brandi, stated that after using the standards-based template she still did not view the Standards documents as influential in planning science instruction.

Although the CD recommends teachers consult the *Benchmarks* (American Association for the Advancement of Science, 1993), NSES (NRC1996), Tennessee Curriculum Standards (Tennessee Department of Education, 2007), and SFAA

(American Association for the Advancement of Science, 1990), the Tennessee Curriculum Standards was the only source consistently viewed as influential in novice pre-service secondary science teachers' lesson planning. The NSES were viewed as the second most influential source when planning science lessons, as three out of the six participants stated that the NSES were influential when making planning decisions.

Planning with Standards-Based Science Software

Learning about Standards is neither simple nor direct. Standards are most effectively learned and demystified through use (Audet & Jordan, 2003a). Only by continually referencing and applying new understandings about standards do these become deeply entrenched in professional practice. Tennessee's Next Generation Tools for Teaching Standards-Based Science CD requires pre-service teachers to respond in new ways to the need for change and to rebuild the very foundation of their thinking about teaching and learning (National Staff Development Council, 2000). Although participants found the CD difficult to navigate, each of the six participants found the resources and lesson template on the CD to be beneficial. Participants plan to use the CD in future lesson planning, especially during student teaching. This statement by each of the participants is promising to the future of science education, since the CD was created as part of the implementation of science education reform.

Implications for Practice

Although experienced teachers may plan the components of a lesson plan in a similar sequence to that of pre-service teachers, the entire process may not be transparent to pre-service teachers (Doyle & Holm, 1998). This study suggests that teacher educators

should dialogue about the place of structured lesson plan creation in initial teacher preparation programs. At this early stage, novice pre-service teachers need to understand the purpose of lesson planning, the value of science education reform documents, and be exposed to strategies of using these documents to guide their decision-making.

This study explored how pre-service secondary science teachers approached planning for science instruction. I analyzed the participants' lesson plan documents, use of Tennessee's Next Generation Tools for Teaching Standards-Based Science CD, version 1.4, the patterns that guided the development of their plans, and their reflections on and reactions to their planning process,.

The primary purpose of lesson planning in teacher preparation programs is to provide pre-service teachers with a good opportunity to learn in a constructivist environment (Sanchez & Valcarel, 1999). Carefully observing lesson plans makes it possible for pre-service science teacher educators to make adjustments to facilitate the needs of all pre-service teachers.

The lesson template required in this course emphasized science education reform documents and Standards. Participants arrived at the final destination of a complete science lesson plan by various routes. Through their use of the CD, lesson template, and science reform documents, students began planning at different places in the process and were influenced differently by these resources. Sanchez and Valcarel (1999) and Strangis, Pringle, & Knopf (2006) found that pre-service science teachers typically began lesson planning by thinking of the content knowledge. My results studying novice pre-service secondary science teachers were consistent with the findings of those investigators.

The study provides links between science teacher preparation and action as related to planning instruction. This study also opens dialogue among teacher educators about the place of science education reform documents in initial teacher education, the role of pre-service teachers' beliefs about science reform, and what is acceptable and appropriate in the planning process. Findings in this study offered insights regarding the needs of pre-service teachers in the process of learning to teach, specifically, developing lesson plans. The TPTE 353 course embraced the notion of constructivism as a theoretical framework in teaching and learning. However, we need to communicate to pre-service teachers how reflecting on lesson planning can be consistent with the constructivist approach. This investigation identified the need for university instructors to engage in dialogue about the disconnect experienced by pre-service teachers between planning science instruction and following the recommendations of science education reform.

Recommendations for Research

General research recommendations include:

- The use of multiple data sources in this study helped provide a more accurate picture of the beliefs and behaviors of each pre-service secondary science teacher.
- A suggestion for an improved research design for this study (and similar efforts) would be to initiate observations in the following fall semester. Post-observations should be conducted during the fall semester to observe participants during their student teaching to examine the planning and teaching

practices being used. Interviewing participants during their student teaching would also elicit a further developed opinion on lesson planning.

Recommendations for additional research regarding standards-based science planning that have developed from this study include:

- Conduct a follow-up study with the same pre-service secondary science teachers involved in the current study to determine if they are continuing to include standards in their planning decisions. Additional professional development could be provided on an as needed basis.
- Another extension involves incorporating pre-service teacher performance as part of the research design in order to demonstrate their planning decisions. The pre-service teachers could be observed and interviewed over the length of a school year (at beginning, mid, and end of year). Pre-service teachers should be observed and interviewed at the same points during the year. Lesson plan documents and reflections could be examined as well.

A potential follow-up study would be to include mentor teachers in the study. It would be interesting to observe the mentoring and teaching practices that would also be impacting pre-service secondary science teachers' planning.

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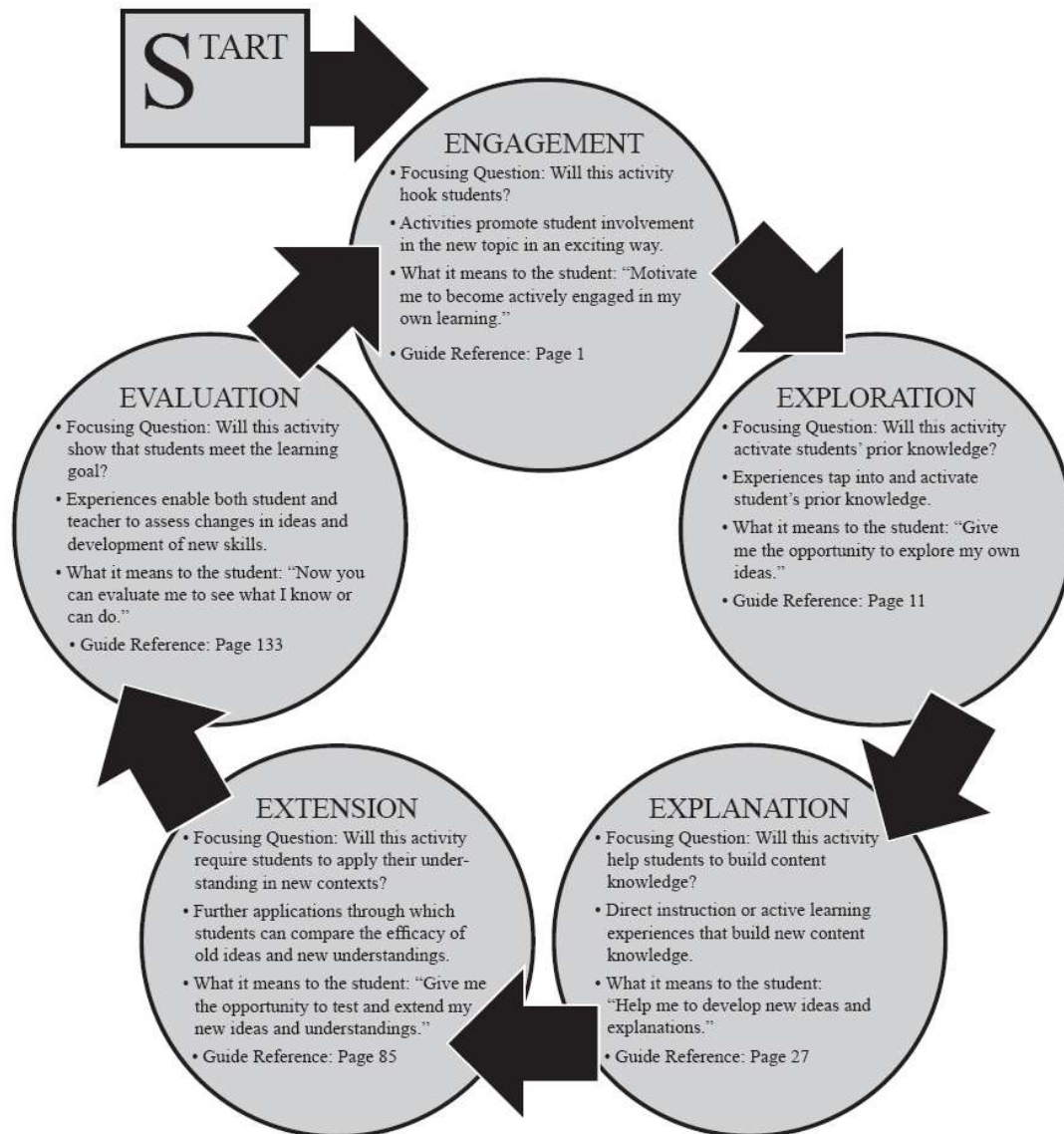
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APPENDICES

FIGURE 5.3

LEARNING CYCLE MODEL OF INSTRUCTION



Appendix B – Lesson Template

Lesson Title: STAGE OF LEARNING CYCLE: FOR THE TEACHER		>>> Go to FOR THE STUDENT...	1
LESSON OVERVIEW	What are the basic elements of this lesson and what is its purpose? Provide an overview for this lesson here.		
INSTRUCTIONAL GOALS	What is the student expected to know or be able to do? Enter instructional goals here.		
FORMATIVE ASSESSMENT	How will the progress of the student be monitored? Enter assessment guidelines here.		
LESSON ORGANIZATION	Opening the Lesson: -- minutes	Enter activities here.	

	Developing the Lesson: __ minutes	Enter activities here.
	Closing the Lesson: __ minutes	Enter activities here.
TEACHING RESOURCES	What materials, equipment, and supplies will be needed to implement the lesson? Enter resources needed to implement the lesson here.	
LAB SAFETY	Are there any special safety concerns that must be addressed? Enter them here.	

ACCOMMODATIONS FOR SPECIAL LEARNERS	How does this lesson need to be modified to accommodate the needs of all students? Enter them here.
ENRICHMENT ACTIVITIES	What activities can be used for enrichment? Enter them here.
STANDARDIZED TEST ITEM GENERATOR	What are some of the released state standardized test items that can be integrated into this lesson? Enter them here.
>Goto State Exam Test Items...	

Lesson Title: OF LEARNING CYCLE: FOR THE TEACHER		STAGE	>>> Go to FOR THE STUDENT...	1
LESSON OVERVIEW	What are the basic elements of this lesson and what is its purpose? Provide an overview for this lesson here.			
INSTRUCTIONAL GOALS	What is the student expected to know or be able to do? Enter instructional goals here.			
FORMATIVE ASSESSMENT	How will the progress of the student be monitored? Enter assessment guidelines here.			
LESSON ORGANIZATION	Opening the Lesson: __ minutes	Enter activities here.		
	Developing the Lesson: __ minutes	Enter activities here.		

	Closing the Lesson: -- minutes	Enter activities here.
TEACHING RESOURCES	What materials, equipment, and supplies will be needed to implement the lesson? Enter resources needed to implement the lesson here.	
LAB SAFETY	Are there any special safety concerns that must be addressed? Enter them here.	
ACCOMMODATIONS FOR SPECIAL LEARNERS	How does this lesson need to be modified to accommodate the needs of all students? Enter them here.	

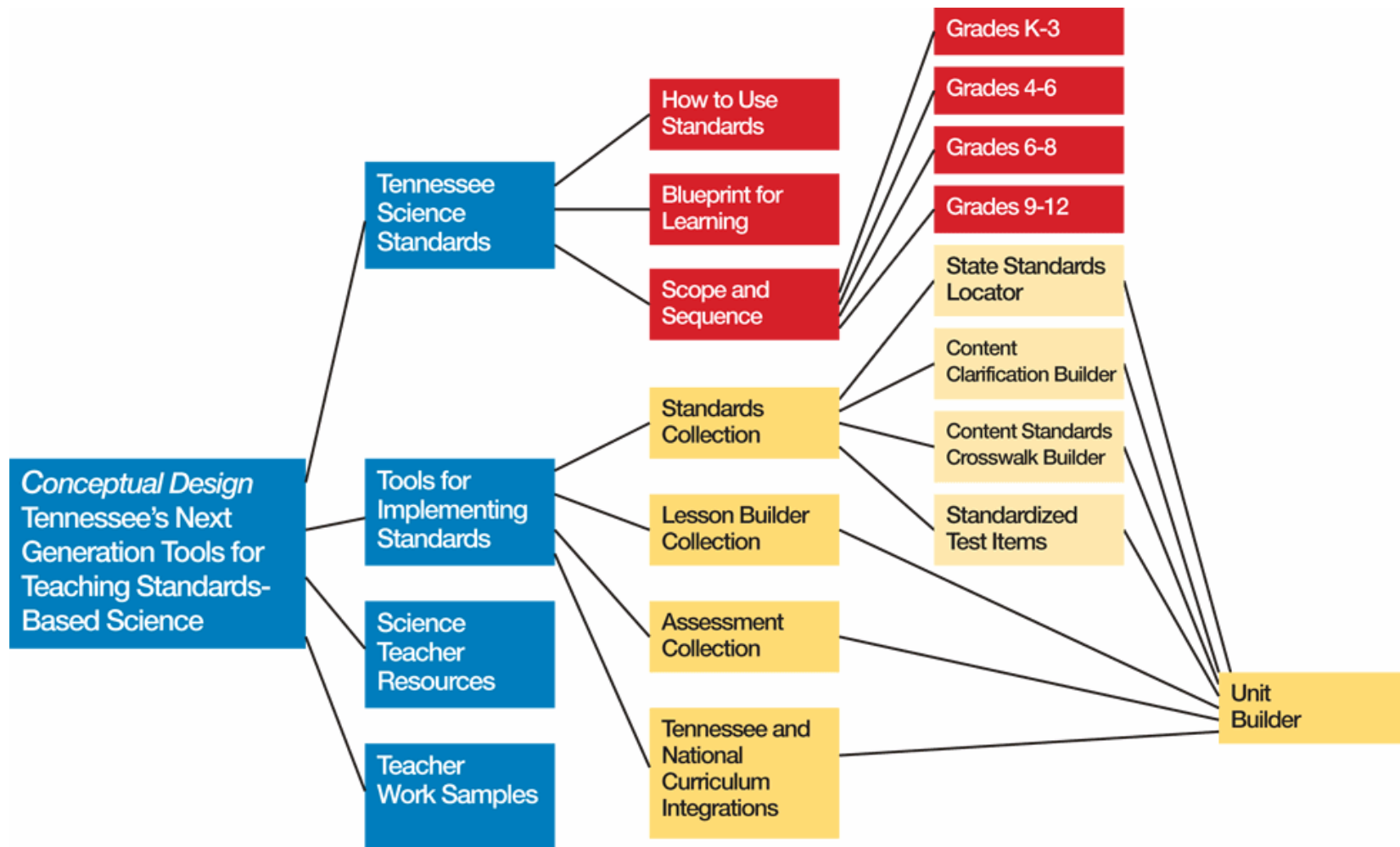
ENRICHMENT ACTIVITIES	What activities can be used for enrichment? Enter them here.
STANDARDIZED TEST ITEM GENERATOR	What are some of the released state standardized test items that can be integrated into this lesson? Enter them here.
> Goto State Exam Test Items...	

Lesson Title: CYCLE: FOR THE TEACHER		STAGE OF LEARNING	>>> Go to FOR THE STUDENT...	1
LESSON OVERVIEW	What are the basic elements of this lesson and what is its purpose? Provide an overview for this lesson here.			
INSTRUCTIONAL GOALS	What is the student expected to know or be able to do? Enter instructional goals here.			
FORMATIVE ASSESSMENT	How will the progress of the student be monitored? Enter assessment guidelines here.			
LESSON ORGANIZATION	Opening the Lesson: __ minutes	Enter activities here.		
	Developing the Lesson: __ minutes	Enter activities here.		

	Closing the Lesson: __ minutes	Enter activities here.
TEACHING RESOURCES	What materials, equipment, and supplies will be needed to implement the lesson? Enter resources needed to implement the lesson here.	
LAB SAFETY	Are there any special safety concerns that must be addressed? Enter them here.	
ACCOMMODATIONS FOR SPECIAL LEARNERS	How does this lesson need to be modified to accommodate the needs of all students? Enter them here.	

ENRICHMENT ACTIVITIES	What activities can be used for enrichment? Enter them here.
STANDARDIZED TEST ITEM GENERATOR	What are some of the released state standardized test items that can be integrated into this lesson? Enter them here.
> Go to State Exam Test Items...	

Appendix C – Table of Contents of Tennessee’s Next Generation Tools for Teaching
Standards-Based Science CD, version 1.4



Appendix D – Participant Informed Consent Form

Informed Consent Form for Members of the TPTE Course – Community Agency Field Experiences Seminar

You are invited to participate in a research study. The purpose of this study is to determine ways to better prepare pre-service teachers for their internship experience. The goal of this course is to enhance pre-service teachers' awareness of factors that impact schools, educators, student learning, and motivation to learn. Course objectives include increased student knowledge and understanding of:

- School contexts (high school and middle school; urban and suburban)
- The needs of students and their families, particularly those who are not achieving at expected levels
- The role of community services supporting students and their families
- The use of technology to enhance communication and to find resources to improve teaching and learning.

Your participation in this study may include the following:

- Keeping a journal of your experiences (readings, classroom and community agency [Cansler YMCA participation] within the course. This journal may be collected at the end of the semester and analyzed qualitatively for emergent themes that exemplify your experiences.
- Completing instruments designed to determine your multicultural awareness/competency, education, teaching, Professional beliefs about diversity, Personal beliefs about diversity & Multicultural Quiz [Multicultural Efficacy Scale]).
- Participating in small “focus groups” for discussion of your experiences, at the end of the semester, videotaped for ease of transcription. The focus groups will be conducted and transcribed by a person who is not a teacher in this course. Tapes will be destroyed after transcription and a pseudonym will be assigned to you. No connection will ever be made to you by anything you say about the course.
- Completing a case study of your experiences at the community agency.
- Providing the last four digits of your social security number for use in coding data.
- Participating in a 45-60 minute interview for discussion of your experiences and opinions as a pre-service science teacher, during the semester, audio taped for ease of transcription. The interview will be conducted and transcribed by a person who is not a teacher in this course. Tapes will be destroyed after transcription and a pseudonym will be assigned to you. No connection will ever be made to you by anything you say about the course.
- Submitting reflections after completing assignments. The reflections will be structured and you will be asked to respond to specific portions of assignments and your experience completing them. Reflections will be collected at the time assignments are due and analyzed qualitatively for emergent themes that exemplify your experiences.

Risk of Participation

There are minimal risks involved in completing the study. The information provided will be considered for publication in formal research documents at the University of TN and professional educational journals/conferences. Any information provided by you that could reveal your identity, including your name, will remain confidential and anonymous in any published materials.

Benefits

The benefits are the likelihood that this project will provide participants with experience and confidence with working in a variety of settings associated with schools. The experience in school settings can help you decide what grade level(s) you would like to teach and help determine with whom you will complete your internship next school year. Working in community agencies, can provide a new perspective of the experiences that may be held by students that you will teach in the future.

Confidentiality

The information in the study records will remain confidential and be stored securely. However, as stated, the information provided will be used as part of formal scientific presentations and every possible effort will be taken to minimize recognition of the participants (e.g. pseudonyms). No direct reference will be made in oral and written reports which could link you to the study.

Contact

If you have questions at any time about the study or the procedures, you may contact the researcher, Dr. C. T. Melear at A406 Claxton Addition, phone number (865) 974-5394. If you have questions about your rights as a participant, contact the Compliance Section of the Office of Research at (865) 974-3466.

Participation

Your participation in this study is voluntary; you may decline to participate without penalty. If you decide to participate, you may withdraw from the study at anytime without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed upon request.

Consent

I have read the above information. I have received a copy of this form. I agree to participate in this study.

Participant's name (print) _____

Participant's signature _____ Date _____

Last 4 digits of your social security number _____

Appendix E – Semi-structured Interview Protocol

Semi-structured Interview Protocol

Review consent form and confirm that student understands taping and transcribing procedure. Reassure about procedures for ensuring confidentiality and anonymity.

Name: Date:

Please tell me about yourself: Your age, your year in school, and your major. What are you doing this semester?

Are you doing any lesson planning this semester? Please describe how that is going. Have you had experience writing lesson plans prior to TPTE 353? Please describe.

How many?

What do you feel is the purpose of writing lesson plans?

You might remember writing your first lesson plan for this course. I have a lesson plan you created and your reflection about lesson planning. Please look these over to refresh your memory. (Give student documents to read over.) I have some questions based your reflection/ lesson plan.

In your reflection, you said _____. Could you tell me what you meant by this?

In your lesson plan, you said _____. Please explain how you use the state standards.

How about planning for the activity (hard/easy)? Why or why not. How about evaluating your students (hard/easy)? Why or why not. How about writing objectives (hard/easy)? Why or why not.

Describe for me now how you would typically plan for a lesson. (Probe for sequence if not volunteered.)

Why do you think you plan a lesson in that order?

What do you think is the most important part of the lesson plan? Why?

Provide a copy of the "Conceptual Design" concept map. During SCED 353,

Please describe how the Next Generations CD has been beneficial or has not been beneficial to you.

If the CD has been beneficial, please identify which portions have been most useful. How?

If the CD has not been beneficial, why do you believe the CD is not useful?

How many times would you estimate you use the CD per week? Per month? Do you see yourself using the CD after this course and field placement?

Today is there anything else you wish to tell me about lesson planning or the TN Next Generations CD?

Appendix F – The University of Tennessee Science Education Trach II Program

The University of Tennessee
Department of Theory & Practice in Teacher Education
Master of Science Program in Teacher Education
SECONDARY SCIENCE EDUCATION LICENSURE (7-12)
Track II

Introduction. The College of Education, Health & Human Sciences, The University of Tennessee, has one of the few nationally ranked teacher licensure programs. The major distinctions of this program are as follows: admission is very selective, candidates have completed a Bachelor's Degree, a one-year internship guarantees a full range of professional experiences, the internship counts as one year's experience, and a Masters Degree can be completed in the process. Since this teacher licensure internship is competitive, interested persons should think and plan ahead.

1. Pre-Admission to the SCIENCE Education Licensure program

Candidates must complete at least 75 semester hours of college courses with 2.70 overall grade point average (g.p.a.). Candidates' overall g.p.a. in the desired licensure subject BIOLOGY, CHEMISTRY, PHYSICS, or GEOLOGY (BCPorG) should be **2.5** or higher.

Candidates must complete two required screening tests – a speech and hearing examination and a basic skills test called the Praxis 1: Pre-professional Skills Test (PPST). There are two exemptions from the PPST: 1) candidates with enhanced ACT scores of 22 or combined SAT scores of 1020 and 2) candidates with a Bachelor's degree. Times, dates, and registration materials for these screening tests are available in the College's Advising office, A 332 Claxton.

Candidates should enroll in TPTE Special Topics – Scientific Research* (Previously LS 593), Spring Semester, 2008 or discuss with the Science Education Advisor (see below) how the independent study in science research guideline for licensure will be fulfilled.

2. Admission into SCIENCE Education

Candidates should complete all of the above requirements during the junior or senior year or as soon as possible if one has a Bachelors Degree. Post-Baccalaureate candidates not holding a degree in BIOLOGY, CHEMISTRY, PHYSICS, OR GEOLOGY must eventually complete 30 semester hours in the desired licensure subject (BCPorG) to include 15 semester hours at the 300 level or higher.

- a. A geology course is now required of all candidates before licensure.
- b. After all of the above screening tests have been completed, candidates can apply to be interviewed with the Science Education Admission Board. Candidates may interview as early as the sophomore year. The Board makes recommendations to the Science Education Advisor(s) who make the final decision regarding who is admitted to the Science Education Licensure Track II program. Candidates should plan ahead by meeting prerequisites and being interviewed no later than the fall semester preceding the internship year. (Admitted candidates may be accepted for the following fall or a subsequent fall depending upon available slots.)
- c. Application to the Graduate School should precede the year of internship. Undergraduate students will continue to meet with their science department advisor until completion of the baccalaureate degree. **However, after admission to the SCIENCE Education Licensure Track II, each candidate is responsible for meeting with the SCIENCE Education advisor (listed on page 2) each semester prior to the internship or risk losing admission status.**

3. Completing the Required Professional Courses

- a. Admitted candidates will complete a prescribed set of courses. Certain courses must be completed before the internship year begins, other courses must be taken in conjunction with the internship, and the remainder are normally completed following the internship. Apple Corp 100 is recommended.

The courses required prior to the internship (normally completed the preceding Spring and/or Summer semesters) are as follows: some may be taken without admission (as indicated by the asterisk, **), but the other require admission to SCIENCE Education: **PSYCEd 401** (3 hr), **SPE ED 402** (3hr), **TPTE 352**** (1 hr), **TPTE 353**** (1 hr), **355** (3 hr), **IT 486** (3 hr); and **Educational Psychology 210**** (3 hr). {**PSYCEd 401** and **SPEED 402** were reconfigured into two 3 hr courses after Summer, 2007 and **CSE 400 (2 hr)** will no longer be required}.

- b. Fall Semester of the Professional Year internship

All Internships begin the first day of the school year, i.e., the first day faculty in public schools report in July or August, and end in May or June of the following year. Internships do not begin in January. During the Fall Semester, interns work in their schools the first half of the day; during the second half of the day, interns meet the course requirements that follow.

SCI Ed 496	Teaching Science, 7-12	3 hours
READ 461	Developing Reading Skills in the Content Field	3 hours
ED 574	Analysis of Teaching	2 hours
ED 575	Internship	4 hours

- c. Spring Semester of the Professional Year Internship

During this semester, interns work in their schools full time (all day) and take one course in the evening.

ED 575	Internship	hours	8
ED 591	Clinical Studies (action research)	hours	4

Summer Semester following the Professional Year internship (**12 hours to complete the Masters degree**). These courses may be completed earlier in the program if scheduling permits, but you must be enrolled in graduate school.

*****Select from the following:** Notice: All students are required to take two graduate science education courses, only one of which can be an online course.

SCI ED 506 Science Education Studies in Natural Environments **Mini Term, 2008** 3 hrs
Contact Dr. Melear regarding this Field Trip Course to Skidaway Island, near Savannah, Ga May 27-31. Three pre-trip classes will be held at night in May and two post-trip classes will be June, TBA. Information and a brochure of previous trips is available at the website <http://web.utk.edu/~ctmelear/skidaway>. 2008 Brochure, available in January. On island costs \$325.

SCI Ed 506	Science Education Studies in Natural Environments	1 st Sum Sess, 2008	3 hrs
Contact Dr. Hagevik at rhagevik@utk.edu about this week-long course at Grandfather Mt., NC, June 23-27, 2008			
SCI Ed 509	Ed for Sustainable Development: Making Connections (Sall)	1 st Sum Sess, 2008	3 hrs
SCI Ed 510	Theoretical Foundations of Environmental Ed (Hagevik)	Fall 2008	3 hrs
SCI Ed 543	Middle School Science Methods (Aydeniz)	Fall 2008	3 hrs
SCI Ed 565	Instructional Trends in Science Ed. (Lunsford)	2 nd Sum Sess 2008	3 hrs
SCI Ed 565	Instructional Trends in Science Ed. (Aydeniz)	Online Full Sum Sess 2008	3 hrs

SCI Ed 596	Curriculum Trends in Science Education (Aydeniz) Online, 1 st Sum Sess 2008	3 hrs
SCI Ed 596	Curriculum Trends in Science Education (Lunsford) 2 nd Sum Sess 2008	3 hrs

Required TPTE 517 Current Trends and Issues in Education Most semesters 3 hrs

Required TPTE 595* Special Topics – Scientific Research Spring, 2008 M W 5-8pm 3 hrs

Offered Spring Semester, 2008 and required of all new graduates seeking biology certification

*Or an independent study course in research in the major. Discuss with science education advisor.

If enrolled in graduate school, **TPTE 595 Scientific Research*** can be applied to the 12 hours toward the M.Ed.

****May be taken before admission to program. Please enroll in 352, along with Ed 353, in spring semester only.**

*** All elective hours in the graduate program must be approved in advance by the

Secondary Science Education Advisor: Dr. Claudia T. Melear, 406 BEC, ctmelear@utk.edu, 974-5394
Secretary, Ms. Beth Huemmer, 405 BEC, 974-7712

Note: This information is effective through Summer 2008.

Appendix G – TPTE 353 Course Syllabus

**Community-Based Field Experiences Seminar for Middle and Secondary Science
Spring 2007**

Wed 1:25-3:15

A428 Claxton and at the Cansler Family YMCA

Instructor: Dr. Claudia Melear
ctmelear@utk.edu Voice 974-5394

Send phone or email message if you will not attend class

Office Hours: Before and after class with Dr. Melear in A406 Claxton or by appointment.

Class Schedule: See Calendar

The seminar will meet on Wednesday in A 428 Claxton Addition. At various points throughout the semester, classes may meet in other settings, but students will be notified of these changes well in advance. Seminar participants who are absent for more than two class sessions will not receive credit for this course. The following numerous National and State Standards and the Tennessee Framework are addressed in this course:

Tennessee Standard 3: Candidates understand how students differ in their approaches to learning	and create instructional opportunities that are adapted to diverse learners
--	--

Tennessee Framework: Indicator C: Adapts instructional opportunities for diverse learners
--

And INTASC 3, National Science Teachers Association (NSTA) Standards 3,5,7

Rationale:

According to the Tennessee Teacher Licensure Standards for Professional Education guidelines, field experiences linked with community agencies and services addressing the needs of urban students and their families correlate with NCATE, INTASC, and NSTA standards as well as principles proposed by UNITE (Urban Network to Improve Teacher Education). As one NSTA report concluded, *“The best programs involve prospective teachers in the community early and provide methods and opportunities for the teachers to become familiar with available resources. They require demonstrated interaction with families and community resources to involve them in science teaching during field experiences and may require some service learning in some courses. Such programs require evidence that candidates understand the cultures of their students and use examples and references from different cultures to involve these students (NSTA Standards for Science Teacher Preparation, p.36).”*

Objectives:

1. Strengthen pre-service teachers’ awareness of their own culture and those other than their own so they are encouraged to consider culture in their approach to teaching.
2. Assist teachers in recognizing and embracing the diverse needs and assets of multicultural communities.
3. Sensitize preservice teachers to the family and community factors that impact schools, educators, student learning, and motivation to learn.
4. Increase novice teachers’ awareness of social justice and equity issues and how they impact urban schools, students, and communities.
5. Introduce preservice teachers to some theories of multicultural education and related terminology.
6. Provide specific cultural contributions by scientists and inventors of color and/or women.

Required Materials and Readings:

- Journal for your field notes and reflections

- TN Next Generation CD for Standards Based Teaching – preview before Feb 21 class use
- Vocabulary familiarity - useful for teaching urban youth. Examples include but are not restricted to: Culturally Responsive Teaching or Pedagogy, “Agency” (not agency as in the Y), Science as a Culture, “Western Science”, Equitable Science Teaching, Urban Sensibilities, etc.
- Various handouts provided by instructors or on directed websites

Grading Policies:

The Field Experience Seminar is graded on a "Satisfactory" or "No Credit" system. In order to receive credit, you must:

1. Be punctual at UT and at the Y. Sign in using the “UT Science Education “ sign in book.
2. Be prepared to discuss homework, assigned readings, focused observations, or other assignments. All assignments must be completed by established due dates.
3. Be an active and involved participant in group / class discussions.
4. Submit bi-weekly reports* on hard copy and cumulatively on a cd in a word document. *
5. Submit completed time logs from Y work (due May 1).
6. Submit a narrative of your own culture obtained from family members. A list of signifiers will be discussed and distributed.
7. Complete required hours at the YMCA (24 minimum).
8. Complete a culturally responsive lesson using the Tn Next Generation CD format.
9. Work with the children and staff at the Y.
10. Talk with at least one child at the Y their lives. Choose one or two children (or staff) to focus on. You may work in pairs on this assignment.
11. Plan with others a culminating activity of some kind for the children and staff at the Y
12. Complete a final report of the field work at the Y**

*After you begin work at the Y, complete a word document bi-weekly by email describing your work, observations, concerns, and thoughts, to the instructor. Accumulate all of these bi-weekly submissions on a cd in a single word document and submit them by May 1 to Dr. Melear.

Label it exactly this way: Your name and the date. Ex: Smith Journal.07. A list of due dates will be distributed for this and the other assignments. Also include all written assignments on the cd as well as hard copy.

The **final report will be based on your weekly field notes and your interviews with a child/person. *Field notes are taken on-site in an unobtrusive manner*, as a way of describing and remembering who all the Y participants are, including staff, what the schedule of activities is, and *what the participants actually do and say*, and including what you do when you begin interacting with the children. For this reason, I suggest you

“pair” with another intern and take turns interacting with a single child, as a goal. Additional instructions to facilitate a good final report will be distributed later.

Written Assignments:

1. Final Report based on Biweekly Field Notes, beginning Feb 7, hard copy. Cumulate them on a cd (4 & 12 above) and summarize with “Lessons Learned.”
2. Your cultural narrative (6) Date TBD. Begin interviewing family members now (6)
3. Culturally Responsive Lesson Plan using the Tn Next Generation CD format (5E) (8)
4. Culminating Activity at the Y (11 – can be included as Culturally Responsive Lesson Plan or in Final Report)

Appendix H – Chase’s Draft Lesson Plan

TENNESSEE SCIENCE UNIT				
COVER SHEET	 Go to Content Clarification	 Go to Performance Assessment	 Go to Curriculum Interactions	Note: This document contains active and powerful links to Internet resources for building your Standards-Based science unit. After you enter material to this Unit Builder, you should
UNIT TITLE	Enter unit title here.			
AUTHOR(S)	Enter author(s) here.			
COURSE/ GRADE LEVEL	Enter course/grade level here.			
CONTENT AREA	Enter content area here.	TOPIC	Enter unit topic here.	
TIME FRAME	Enter time frame here.	NUMBER OF LESSONS	Enter number of lessons in this	
TARGETED TENNESSEE STANDARDS/ LEARNING EXPECTATIONS	What specific TN standards, Learning Expectations, and State Performance Indicators are targeted in this unit?			

SUMMARY OF PERFORMANCE ASSESSMENT	What products or actions are expected of students upon completion of the unit?
OVERVIEW OF STUDENT LEARNING ACTIVITIES	
 LESSON 1	Provide an overview for lesson 1 here.
Enter Learning Cycle stage here. Enter lesson 1 title here.	
 LESSON 2	Provide an overview for lesson 2 here.
Enter Learning Cycle stage here. Enter lesson 2 title here.	
 LESSON 3	Provide an overview for lesson 3 here.
Enter Learning Cycle stage here. Enter lesson 3 title here.	
 LESSON 4	Provide an overview for lesson 4 here.
Enter Learning Cycle stage here. Enter lesson 4 title here.	
 LESSON 5	Provide an overview for lesson 5 here.

Enter Learning Cycle stage here. Enter lesson 5 title here.	
 LESSON 6	
Enter Learning Cycle stage here. Enter lesson 6 title here.	Provide an overview for lesson 6 here. Delete row if necessary.
 LESSON 7	
Enter Learning Cycle stage here. Enter lesson 7 title here.	Provide an overview for lesson 7 here. Delete row if necessary.
 LESSON 8	
Enter Learning Cycle stage here. Enter lesson 8 title here.	Provide an overview for lesson 8 here. Delete row if necessary.

CONTENT CLARIFICATION	 Go to Cover Sheet  Go to Performance  Go to Curriculum Go to Lesson... 1 2 3 4 5 6 7 8
SCIENCE STANDARDS	
Go to...  K-3  4-5  6-8  9-12 COURSES	<u>Standard Number:</u> 1.0 Force and Motion The student will explore the concepts of force and motion. <u>Learning Expectations:</u> 1.4 demonstrate the relationship among work, power, and machines. <u>Performance Indicators State (SPI) and Teacher (TPI):</u> Level 1: SPI identify simple machines, given illustrations of machines in action. TPI design, construct, and demonstrate simple machines using various materials. Level 2: SPI recognize the simple machines found in a compound machine, given an illustration of a machine in action. TPI design, demonstrate, and explain a compound machine.
ASSOCIATED K-12 NATIONAL SCIENCE STANDARDS AND BENCHMARKS	
 Go to Science Netlinks...	BENCHMARKS FOR SCIENCE LITERACY
K-2 BENCHMARKS	A. Technology and Science By the end of 2nd grade, students should know that: Tools are used to do things better or more easily and to do some things that could not otherwise

	be done at all. When trying to build something or to get something to work better, it usually helps to follow directions if there are any or to ask someone who has done it before for suggestions.
3-5 BENCHMARKS	A. Technology and Science By the end of 5th grade, students should know that: Throughout all of history, people everywhere have invented and used tools. In earlier times, the accumulated information and techniques of each generation of workers were taught on the job directly to the next generation of workers. Today, the knowledge base for technology can be found as well in libraries of print and electronic resources and is often taught in the classroom. Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly. Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds.
6-8 BENCHMARKS	A. Technology and Science By the end of 8th grade, students should know that: In earlier times, the accumulated information and techniques of each generation of workers were taught on the job directly to the next generation of workers. Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information. Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems.
9-12 BENCHMARKS	A. Technology and Science By the end of 12th grade, students should know that: Technological problems often create a demand for new scientific knowledge, and new

	technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. Mathematics, creativity, logic and originality are all needed to improve technology. 3. Technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs).
 Go to NSES...	NATIONAL SCIENCE EDUCATION STANDARDS Which National Science Education Standards address the same topic that you are targeting for instruction? In Chapter 6, locate <u>all</u> of the standards for K-4, 5-8 and 9-12 related to this topic. Copy and paste the information here.
K-4 STANDARDS	PROPERTIES OF OBJECTS AND MATERIALS Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers. Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials. Materials can exist in different states--solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.
5-8 STANDARDS	MOTIONS AND FORCES The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.[See Content Standard D (grades 5-8)] An object that is not being subjected to a force will continue to move at a constant speed and in a straight line. If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.

9-12 STANDARDS	MOTIONS AND FORCES Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F = ma$, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.
RELATED CONTENT KNOWLEDGE	
 Goto Science for All Americans...	Chapter 4: THE PHYSICAL SETTING Energy Transformations Motion
 Goto Benchmarks for Science Literacy...	ENERGY TRANSFORMATIONS Energy appears in many forms, including radiation, the motion of bodies, excited states of atoms, and strain within and between molecules. All of these forms are in an important sense equivalent, in that one form can change into another. Most of what goes on in the universe—such as the collapsing and exploding of stars, biological growth and decay, the operation of machines and computers—involves one form of energy being transformed into another. Forms of energy can be described in different ways: Sound energy is chiefly the regular back-and-forth motion of molecules; heat energy is the random motion of molecules; gravitational energy lies in the separation of mutually attracting masses; the energy stored in mechanical strains involves the separation of mutually attracting electric charges. Although the various forms appear very different, each can be measured in a way that makes it possible to keep track of how much of one form is converted into another. Whenever the amount of energy in one place or form diminishes, the amount in another place or form increases by an equivalent amount. Thus, if no energy leaks in or out across the boundaries of a system, the total energy of all the different forms in the system will not change, no matter what kinds of gradual or violent changes actually occur within the system. But energy does tend to leak across boundaries. In particular, transformations of energy usually result in producing some energy in the form of heat, which leaks away by radiation or conduction (such as from engines, electrical wires, hot-water tanks, our bodies, and stereo systems). Further, when heat is conducted or radiated into a fluid, currents are set up that usually enhance the transfer of heat. Although materials that conduct or radiate heat very poorly can be used to reduce heat loss, it can never be prevented completely. Therefore the total amount of energy available for transformation is almost always decreasing. For example, almost

all of the energy stored in the molecules of gasoline used during an automobile trip goes, by way of friction and exhaust, into producing a slightly warmer car, road, and air. But even if such diffused energy is prevented from leaking away, it tends to distribute itself evenly and thus may no longer be useful to us. This is because energy can accomplish transformations only when it is concentrated more in some places than in others (such as in falling water, in high-energy molecules in fuels and food, in unstable nuclei, and in radiation from the intensely hot sun). When energy is transformed into heat energy that diffuses all over, further transformations are less likely.

MOTION

Motion is as much a part of the physical world as matter and energy are. Everything moves—atoms and molecules; the stars, planets, and moons; the earth and its surface and everything on its surface; all living things, and every part of living things. Nothing in the universe is at rest.

Changes in motion—speeding up, slowing down, changing direction—are due to the effects of forces. Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it. When an unbalanced force does act on an object, the object's motion changes. Depending on the direction of the force relative to the direction of motion, the object may change its speed (a falling apple) or its direction of motion (the moon in its curved orbit), or both (a fly ball).

The greater the amount of the unbalanced force, the more rapidly a given object's speed or direction of motion changes; the more massive an object is, the less rapidly its speed or direction changes in response to any given force. And whenever some thing A exerts a force on some thing B, B exerts an equally strong force back on A. For example, iron nail A pulls on magnet B with the same amount of force as magnet B pulls on iron nail A—but in the opposite direction. In most familiar situations, friction between surfaces brings forces into play that complicate the description of motion, although the basic principles still apply.

PERFORMANCE ASSESSMENT BUILDER		 Go to Cover Sheet  Go to Content Clarification  Go to Integration	
 ROLE OR PERSONA...	 TARGETED BEHAVIOR...	 AUDIENCE...	 PRODUCT OR ACTION...
You are a...	...who has been asked to...	...who has been asked by...	...who will...
PERFORMANCE TASK	You are an engineer who has been asked to come into the classroom to help explain simple and compound machines in everyday life to a science class. Write down on paper the explanation of simple and compound machines, classify the two categories		

CRITERIA FOR SUCCESS	PERFORMANCE INDICATORS				
	What specific levels of student performance are assessed? Enter them in the columns below.				
What are the required features of the product or action? Enter them in the rows below.	5	4	3	2	1
Explanation of simple and compound machines	Gives a perfect description of a simple machine and a compound machine	Gives a perfect description of either simple or compound machine, tries, but needs help on the other one	Gives a perfect description of either simple or compound machine, but no effort on the other one	Tries, but needs help on the description of both simple and compound machines	Has no clue what a simple machine is nor a compound machine
Describe the 6 simple machines	Gives a perfect description of each of the 6 simple machines	Gives a perfect description of 5 of the 6 simple machines	Gives a perfect description of 4 of the 6 simple machines	Gives a perfect description of 3 of the 6 simple machines	Gives a perfect description of 2 of the 6 simple machines

					machines
Give an everyday example of a simple machine	Can give examples of each of the 6 different simple machines	Can give examples of 5 of the 6 different simple machines	Can give examples of 4 of the 6 different simple machines	Can give examples of 3 of the 6 different simple machines	Can give examples of 2 of the 6 different simple machines
Give an everyday example of a compound machine	Can give 3 examples of a compound machine, with no help	Can give 3 examples of a compound machine, with a little help	Can give 2 examples of a compound machine	Can give 2 examples of a compound machine, with a little help	Can give 1 example of a compound machine with or without help
Can classify the two basic types of simple machines	Can identify the two basic categories of the simple machines, and list each of the three simple machines within each category	Can identify the two basic categories of the simple machines, and list at least 2 of the 3 simple machines within each category	Can identify the two basic categories of the simple machines, and list at least 1 of the 3 simple machines within each category	Can identify the two basic categories of the simple machines	Can identify the two basic categories of the simple machines with help
COMMENTS					

CURRICULUM INTEGRATIONS		 Go to TN Curriculum Standards	 Go to Cover Sheet	 Go to Content Clarification	 Go to Performance Assessment	Go to Lesson... 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8
ART	Are there any Art Standards that a student might meet by completing this unit?					
 Go to Art Standards...  TN Art Standards...						
McREL NATIONAL STANDARDS AND BENCHMARKS DATABASE	Are there any associated Standards and Benchmarks in this national compendium that a student might meet by completing this unit?					
 Go to McREL...						
ENGLISH/LANGUAGE ARTS	Are there any English/Language Arts Standards that a student might meet by completing this unit?					
 Go to ELA Standards...  TN English/Language Arts...						
GEOGRAPHY	Are there any Geography Standards that a student might meet by completing this unit?					
 Go to Geography Standards...						
HISTORY	Are there any History/Social Studies Standards that a student might meet by completing this unit?					
 Go to History Standards...						
MATHEMATICS	Are there any Mathematics Standards that a student could meet by completing this unit?					
 Go to Mathematics Standards...  TN Mathematics Standards...						
SOCIAL STUDIES	Are there any Social Studies Standards that a student might meet by completing					

 Go to Social Studies Standards...  TN Social Studies Standards...	this unit?
TECHNOLOGY	
 Go to Technology Standards...  TN Technology Standards	Are there any Technology Standards that a student might meet by completing this unit?

SCIENCE TOP CURRICULUM WEB LINKS:
STARTING POINTS

<u>Access Excellence: National Health Museum</u>	<u>American Chemical Society</u>	<u>Annenberg/CPB Teacher's Lab</u>
<u>Biology Resources and Links</u>	<u>Biozone</u>	<u>Classroom Connect</u>
<u>Discovery School</u>	<u>Education Gateway</u>	<u>Education World</u>
<u>Exploratorium</u>	<u>Explore Learning</u>	<u>How Stuff Works</u>
<u>JASON Project</u>	<u>Journey North</u>	<u>Jokes and Science</u>
<u>Kathy Schrock's Guide for Educators</u>	<u>NASA Education Resources</u>	<u>National Science Teachers Association</u>
<u>National Earth Science Teachers Association</u>	<u>Nearing Zero Science Humor</u>	<u>New York Times Learning Network</u>
<u>North Harris College</u>	<u>NOVA</u>	<u>Performance Assessment Links in Science</u>
<u>Physical Science Resource Center</u>	<u>Science Guides</u> (\$)	<u>Science NetLinks</u>
<u>The Education Index Award Home Page</u>	<u>The Why Files</u>	<u>WebQuest Home Page</u>

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Lesson Title: Simple and compound machines STAGE OF LEARNING CYCLE: FOR THE TEACHER		>>> Go to FOR THE STUDENT...	1
LESSON OVERVIEW	Students are introduced to the definitions of simple and compound machines.		
INSTRUCTIONAL GOALS	The student will be able to identify simple and compound machines in everyday life, and have an understanding why they are used.		
FORMATIVE ASSESSMENT	How will the progress of the student be monitored? After each mini lesson on each of the simple machine and compound machine topics, the student (a random student) will be questioned, and asked to summarize the information. The teacher will have other students help the student who is being questioned.		
LESSON ORGANIZATION	Opening the Lesson: 10 minutes	Ask the class to define what a machine is. Then, ask the class if they could function in a day without using any machine. Introduce a visual of six different simple machines corresponding to the six different simple machine types, and describe how they work.	

	Developing the Lesson: 25 minutes	Go through a detailed explanation on what a simple machine is. Give every day examples of simple machines, using body parts and everyday tools as examples. Go through a detailed explanation on what a compound machine is, and give every day examples of their uses. Hand out a worksheet on simple machines, having the students identify each of the simple machines and give
	Closing the Lesson: 5 minutes	A general questioning of each of the 6 types of simple machines will be asked, and the students will be encouraged to participate in answering the questions.
TEACHING RESOURCES	Hammer, nail, and wood; pulley, rope, and weight; pencil sharpener; board, brick; screw, wood; axe and wood (or door stop).	
LAB SAFETY	Common safety using and handling the demonstration equipment. If the axe is permitted, no student should touch it due to possible injury.	

ACCOMMODATIONS FOR SPECIAL LEARNERS	For students with learning disabilities, or more visual learners, the worksheet will be matching. For the rapid learner, only the instructions will be provided.
ENRICHMENT ACTIVITIES	Students will come up with simple machines they can use to improve their every day lives. These simple machines may be combined to use compound machines.
STANDARDIZED TEST ITEM GENERATOR	The portions of the test that have to do with force and motion, more specifically, simple machines.

Appendix I – Chase’s Final Lesson Plan

TENNESSEE SCIENCE UNIT				
COVER SHEET	 Go to Content Clarification	 Go to Performance Assessment	 Go to Curriculum Integrations	Note: This document contains active and powerful links to Internet resources for building your Standards-Based science unit. After you enter material to this
UNIT TITLE	Enter unit title here.			
AUTHOR(S)	Enter author(s) here.			
COURSE/ GRADE LEVEL	Enter course/grade level here.			
CONTENT AREA	Enter content area here.	TOPIC	Enter unit topic here.	
TIME FRAME	Enter time frame here.	NUMBER OF LESSONS	Enter number of lessons in this	
TARGETED TENNESSEE STANDARDS/ LEARNING EXPECTATIONS	What specific TN standards, Learning Expectations, and State Performance Indicators are targeted in this unit?			

SUMMARY OF PERFORMANCE ASSESSMENT		What products or actions are expected of students upon completion of the unit?
OVERVIEW OF STUDENT LEARNING ACTIVITIES		
 LESSON 1 Enter Learning Cycle stage here. Enter lesson 1 title here.		Provide an overview for lesson 1 here.
 LESSON 2 Enter Learning Cycle stage here. Enter lesson 2 title here.		Provide an overview for lesson 2 here.
 LESSON 3 Enter Learning Cycle stage here. Enter lesson 3 title here.		Provide an overview for lesson 3 here.
 LESSON 4 Enter Learning Cycle stage here. Enter lesson 4 title here.		Provide an overview for lesson 4 here.
 LESSON 5		Provide an overview for lesson 5 here.

Enter Learning Cycle stage here. Enter lesson 5 title here.	
 LESSON 6	
Enter Learning Cycle stage here. Enter lesson 6 title here.	Provide an overview for lesson 6 here. Delete row if necessary.
 LESSON 7	
Enter Learning Cycle stage here. Enter lesson 7 title here.	Provide an overview for lesson 7 here. Delete row if necessary.
 LESSON 8	
Enter Learning Cycle stage here. Enter lesson 8 title here.	Provide an overview for lesson 8 here. Delete row if necessary.

CONTENT CLARIFICATION	 Go to Cover Sheet  Go to Performance Assessment  Go to Curriculum Integrations Go to Lesson... 1 2 3 4 5 6 7 8
SCIENCE STANDARDS	

Goto...  K-3  4-5  6-8  9-12 COURSES	<u>Standard Number:</u> 1.0 Force and Motion The student will explore the concepts of force and motion. <u>Learning Expectations:</u> 1.4 demonstrate the relationship among work, power, and machines. <u>Performance Indicators State (SPI) and Teacher (TPI):</u> Level 1: SPI identify simple machines, given illustrations of machines in action. TPI design, construct, and demonstrate simple machines using various materials. Level 2: SPI recognize the simple machines found in a compound machine, given an illustration of a machine in action. TPI design, demonstrate, and explain a compound machine.
ASSOCIATED K-12 NATIONAL SCIENCE STANDARDS AND BENCHMARKS	
 Go to Science Netlinks...	BENCHMARKS FOR SCIENCE LITERACY
K-2 BENCHMARKS	A. Technology and Science By the end of 2nd grade, students should know that: Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. When trying to build something or to get something to work better, it usually helps to follow directions if there are any or to ask someone who has done it before for suggestions.
3-5 BENCHMARKS	A. Technology and Science By the end of 5th grade, students should know that: Throughout all of history, people everywhere have invented and used tools. In earlier times, the accumulated information and techniques of each generation of workers were

	taught on the job directly to the next generation of workers. Today, the knowledge base for technology can be found as well in libraries of print and electronic resources and is often taught in the classroom. Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly. Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds.
6-8 BENCHMARKS	A. Technology and Science By the end of 8th grade, students should know that: In earlier times, the accumulated information and techniques of each generation of workers were taught on the job directly to the next generation of workers. Technology is essential to science for such purposes as access to outer space and other remote locations, sample collection and treatment, measurement, data collection and storage, computation, and communication of information. Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems.
9-12 BENCHMARKS	A. Technology and Science By the end of 12th grade, students should know that: Technological problems often create a demand for new scientific knowledge, and new technologies make it possible for scientists to extend their research in new ways or to undertake entirely new lines of research. Mathematics, creativity, logic and originality are all needed to improve technology. Technology usually affects society more directly than science because it solves practical problems and serves human needs (and may create new problems and needs).
 Go to NSES...	NATIONAL SCIENCE EDUCATION STANDARDS Which National Science Education Standards address the same topic that you are targeting for

	instruction? In Chapter 6, locate <u>all</u> of the standards for K-4, 5-8 and 9-12 related to this topic. Copy and paste the information here.
K-4 STANDARDS	PROPERTIES OF OBJECTS AND MATERIALS Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances. Those properties can be measured using tools, such as rulers, balances, and thermometers. Objects are made of one or more materials, such as paper, wood, and metal. Objects can be described by the properties of the materials from which they are made, and those properties can be used to separate or sort a group of objects or materials. Materials can exist in different states--solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling.
5-8 STANDARDS	MOTIONS AND FORCES The motion of an object can be described by its position, direction of motion, and speed. That motion can be measured and represented on a graph.[See Content Standard D (grades 5-8)] An object that is not being subjected to a force will continue to move at a constant speed and in a straight line. If more than one force acts on an object along a straight line, then the forces will reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion.
9-12 STANDARDS	MOTIONS AND FORCES Objects change their motion only when a net force is applied. Laws of motion are used to calculate precisely the effects of forces on the motion of objects. The magnitude of the change in motion can be calculated using the relationship $F = ma$, which is independent of the nature of the force. Whenever one object exerts force on another, a force equal in magnitude and opposite in direction is exerted on the first object.

RELATED CONTENT KNOWLEDGE



[Goto Science](#)
for All Americans...

Chapter 4: THE PHYSICAL SETTING

Energy Transformations

Energy appears in many forms, including radiation, the motion of bodies, excited states of atoms, and strain within and between molecules. All of these forms are in an important sense equivalent, in that one form can change into another. Most of what goes on in the universe—such as the collapsing and exploding of stars, biological growth and decay, the operation of machines and computers—involves one form of energy being transformed into another.

Forms of energy can be described in different ways: Sound energy is chiefly the regular back-and-forth motion of molecules; heat energy is the random motion of molecules; gravitational energy lies in the separation of mutually attracting masses; the energy stored in mechanical strains involves the separation of mutually attracting electric charges. Although the various forms appear very different, each can be measured in a way that makes it possible to keep track of how much of one form is converted into another. Whenever the amount of energy in one place or form diminishes, the amount in another place or form increases by an equivalent amount. Thus, if no energy leaks in or out across the boundaries of a system, the total energy of all the different forms in the system will not change, no matter what kinds of gradual or violent changes actually occur within the system.

But energy does tend to leak across boundaries. In particular, transformations of energy usually result in producing some energy in the form of heat, which leaks away by radiation or conduction (such as from engines, electrical wires, hot-water tanks, our bodies, and stereo systems). Further, when heat is conducted or radiated into a fluid, currents are set up that usually enhance the transfer of heat. Although materials that conduct or radiate heat very poorly can be used to reduce heat loss, it can never be prevented completely.

Therefore the total amount of energy available for transformation is almost always decreasing.

For example, almost all of the energy stored in the molecules of gasoline used during an automobile trip goes, by way of friction and exhaust, into producing a slightly warmer car, road, and air. But even if such diffused energy is prevented from leaking away, it tends to distribute itself evenly and thus may no longer be useful to us. This is because energy can accomplish transformations only when it is concentrated more in some places than in others (such as in falling water, in high-energy molecules in fuels and food, in unstable nuclei, and in radiation from the intensely hot sun). When energy is transformed into heat energy that diffuses all over, further transformations are less likely.

The reason that heat tends always to diffuse from warmer places to cooler places is a matter of probability. Heat energy in a material consists of the disordered motions of its perpetually colliding atoms or molecules. As very large numbers of atoms or molecules in one region of a material repeatedly and randomly collide with those of a neighboring region, there are far more ways in which their energy of random motion can end up shared about equally throughout both regions than there are ways in which it can end up more concentrated in one region. The disordered sharing of heat energy all over is therefore far more likely to occur than any more orderly concentration of heat energy in any one place. More generally, in any interactions of atoms or molecules, the statistical odds are that they will end up in more disorder than they began with.

Motion:

Motion is as much a part of the physical world as matter and energy are. Everything moves—atoms and molecules; the stars, planets, and moons; the earth and its surface and everything on its surface; all living things, and every part of living things. Nothing in the universe is at rest.

Since everything is moving, there is no fixed reference point against which the motion of things can be described. All motion is relative to whatever point or object we choose. Thus, a parked bus has no motion with reference to the earth's surface; but since the earth spins on its axis, the bus is moving about 1,000 miles per hour around the center of the earth. If the bus is moving down the highway, then a person walking up the aisle of the bus has one speed with reference to the bus, another with respect to the highway, and yet another with respect to the earth's center. There is no

	point in space that can serve as a reference for what is actually moving. Changes in motion—speeding up, slowing down, changing direction—are due to the effects of forces. Any object maintains a constant speed and direction of motion unless an unbalanced outside force acts on it. When an unbalanced force does act on an object, the object's motion changes. Depending on the direction of the force relative to the direction of motion, the object may change its speed (a falling apple) or its direction of motion (the moon in its curved orbit), or both (a fly ball). The greater the amount of the unbalanced force, the more rapidly a given object's speed or direction of motion changes; the more massive an object is, the less rapidly its speed or direction changes in response to any given force. And whenever some thing A exerts a force on some thing B, B exerts an equally strong force back on A. For example, iron nail A pulls on magnet B with the same amount of force as magnet B pulls on iron nail A—but in the opposite direction. In most familiar situations, friction between surfaces brings forces into play that complicate the description of motion, although the basic principles still apply.
 Go to Benchmarks for Science Literacy...	E. Energy Transformations Energy is a mysterious concept, even though its various forms can be precisely defined and measured. At the simplest level, children can think of energy as something needed to make things go, run, or happen. But they have difficulty distinguishing energy needs from other needs-plants need water to live and grow; cars need water, oil, and tires; people need sleep, etc. People in general are likely to think of energy as a substance, with flow and conservation analogous to that of matter. That is not correct, but for most people it can be an acceptable analogy. Although learning about energy does not make it much less mysterious, it is worth trying to understand because a wide variety of scientific explanations are difficult to follow without some knowledge of the concept of energy. Energy is a major exception to the principle that students should understand ideas before being given labels for them. Children benefit from talking about energy before they are able to define it. Ideas about energy that students encounter outside of school—for example, getting "quick energy" from a candy bar or turning off a light so as not to "waste energy"—may be imprecise but are reasonably consistent with ideas about energy that we want students to learn.

Three energy-related ideas may be more important than the idea of energy itself. One is energy transformation. All physical events involve transferring energy or changing one form of energy into another—radiant to electrical, chemical to mechanical, and so on. A second idea is the conservation of energy. Whenever energy is reduced in one place, it is increased somewhere else by exactly the same amount. A third idea is that whenever there is a transformation of energy, some of it is likely to go into heat, which spreads around and is therefore not available for use.

Heat energy itself is a surprisingly difficult idea for students, who thoroughly confound it with the idea of temperature. A great deal of work is required for students to make the distinction successfully, and the heat/temperature distinction may join mass/weight, speed/acceleration, and power/energy distinctions as topics that, for purposes of literacy, are not worth the extraordinary time required to learn them. Because dissipated heat energy is at a lower temperature, some students' confusion about heat and temperature leads them to infer that the amount of energy has been reduced. On the other hand, some students' idea that dissipated heat energy has been "exhausted" or "expended" may be tolerably close to the truth.

Similarly, units and formulas for kinetic and potential energy are more difficult than they are worth for the semiquantitative understanding that we seek here. But the notion of potential energy is still useful for some situations in which motion might occur (for example, gravitational energy in water behind a dam, mechanical energy in a cocked mousetrap, or chemical energy in a flashlight battery or sugar molecule).

Work, in the specialized sense used in physics, is often considered a useful, even necessary, concept for dealing with ideas of energy. These benchmarks propose to do without a technical definition of work for purposes of basic literacy, because it is so greatly confused with the common English-language meaning of the word. The calculation of work as force times distance is not essential to understanding many important ideas about energy. Running makes you tired; rubbing your hands together makes them warmer; coming out of water makes you feel cool.

Older students can grasp these ideas in a general way, but even they should not be expected to understand them deeply. For young students, it may be enough at first to convince them that energy is needed to get physical things to happen and that they should get in the habit of

PERFORMANCE ASSESSMENT BUILDER		 Go to Cover Sheet				 Go to Content Clarification		 Go to Curriculum Integrations		Go to Lesson... 1 / 2 / 3 / 4 / 5 / 6 / 7 / 8	
 ROLE OR PERSONA...		 TARGETED BEHAVIOR...			 AUDIENCE...			 PRODUCT OR ACTION...			
You are a...		...who has been asked to...			...who has been asked by...			...who will...			
		wondering where the energy came from. Then, as they study physical, chemical, and biological systems, many opportunities arise for them to see the many different forms energy takes and to find out how useful the energy concepts are.									

PERFORMANCE TASK	You are an engineer who has been asked to come into the classroom to help explain simple and compound machines in everyday life to a science class. Write down on paper the explanation of simple and compound machines, classify the two categories of simple				
CRITERIA FOR SUCCESS	PERFORMANCE INDICATORS What specific levels of student performance are assessed? Enter them in the columns below.				
What are the required features of the product or action? Enter them in the rows below.	5	4	3	2	1
Explanation of simple and compound machines	Gives a perfect description of a simple machine and a compound machine	Gives a perfect description of either simple or compound machine, tries, but needs help on the other one	Gives a perfect description of either simple or compound machine, but no effort on the other one	Tries, but needs help on the description of both simple and compound machines	Has no clue what a simple machine is nor a compound machine

Describe the 6 simple machines	Gives a perfect description of each of the 6 simple machines	Gives a perfect description of 5 of the 6 simple machines	Gives a perfect description of 4 of the 6 simple machines	Gives a perfect description of 3 of the 6 simple machines	Gives a perfect description of 2 of the 6 simple machines
Give an everyday example of a simple machine	Can give examples of each of the 6 different simple machines	Can give examples of 5 of the 6 different simple machines	Can give examples of 4 of the 6 different simple machines	Can give examples of 3 of the 6 different simple machines	Can give examples of 2 of the 6 different simple machines
Give an everyday example of a compound machine	Can give 3 examples of a compound machine, with no help	Can give 3 examples of a compound machine, with a little help	Can give 2 examples of a compound machine	Can give 2 examples of a compound machine, with a little help	Can give 1 example of a compound machine with or without help
Can classify the two basic types of simple machines	Can identify the two basic categories of the simple machines, and list each of the three simple machines within each category	Can identify the two basic categories of the simple machines, and list at least 2 of the 3 simple machines within each category	Can identify the two basic categories of the simple machines, and list at least 1 of the 3 simple machines within each category	Can identify the two basic categories of the simple machines	Can identify the two basic categories of the simple machines with help
COMMENTS					

CURRICULUM INTEGRATIONS	 Go to TN Curriculum Standards  Go to Cover Sheet  Go to Content Certification  Go to Performance Assessment Go to Lesson... 1 2 3 4 5 6 7 8
ART	
 Go to Art Standards...  TN Art Standards...	Are there any Art Standards that a student might meet by completing this unit?
McREL NATIONAL STANDARDS AND BENCHMARKS DATABASE	Are there any associated Standards and Benchmarks in this national compendium that a student might meet by completing this unit?
 Go to McREL...	
ENGLISH/LANGUAGE ARTS	
 Go to ELA Standards...  TN English/Language Arts...	Are there any English/Language Arts Standards that a student might meet by completing this unit?
GEOGRAPHY	
 Go to Geography Standards...	Are there any Geography Standards that a student might meet by completing this unit?
HISTORY	
 Go to History Standards...	Are there any History/Social Studies Standards that a student might meet by completing this unit?
MATHEMATICS	
 Go to Mathematics Standards...  TN Mathematics Standards...	Are there any Mathematics Standards that a student could meet by completing this unit?
SOCIAL STUDIES	Are there any Social Studies Standards that a student might meet by completing this

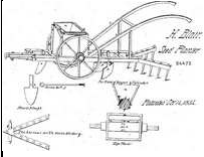
 Go to Social Studies Standards...  TN Social Studies Standards...	unit?
TECHNOLOGY	
 Go to Technology Standards...  TN Technology Standards	Are there any Technology Standards that a student might meet by completing this unit?

SCIENCE TOP CURRICULUM WEB LINKS: STARTING POINTS		
North Harris College	NOVA	Performance Assessment Links in Science
Physical Science Resource Center	Science Guides (\$)	Science NetLinks
The Education Index Award Home Page	The Why Files	WebQuest Home Page
Kathy Schrock's Guide for Educators	NASA Education Resources	Science Teachers Association
National Earth Science Teachers Association	Nearing Zero Science Humor	New York Times Learning Network

Lesson Title: Simple and compound machines STAGE OF LEARNING CYCLE: FOR THE TEACHER		>>> Go to FOR THE STUDENT...	1
LESSON OVERVIEW	Students are introduced to simple and compound machines by observations and examples.		
INSTRUCTIONAL GOALS	The student will be able to identify at least 10 simple and compound machines in everyday life. The student will have an understanding of why the simple machines or compound machines are used, and associate the classification of each (a wedge, an incline, a lever, a pulley, a wheel and axle, or a screw). The student will demonstrate an understanding of each of the six simple machines by illustrating the forces associated with each of the simple machines. The student will present one simple machine found in everyday life to the class, and demonstrate the forces associated with it. The student will compare and contrast each of the six simple machines in a short essay.		
FORMATIVE ASSESSMENT	How will the progress of the student be monitored? After each mini lesson on each of the simple machine and compound machine topics, the student (a random student) will be questioned, and asked to summarize the information. The teacher will have other students help the student who is being questioned.		
LESSON ORGANIZATION	Opening the Lesson: 20 minutes	(The day before this lesson on simple machines is presented; a pre-assessment of their knowledge will be given in a form of a mini quiz. This quiz will be six questions long, having an everyday (picture/illustration) example of each of the six machines illustrated. The student will be asked to identify the object, identify the simple machine associated with it, and illustrate the forces associated with each machine).	

At the start of the class, I will bring in a pile of objects. I will ask the class to break up into groups of 2 or 3 and ask them to sort through the

		pile of objects. Each group will begin to identify categories of the objects. After about ten minutes, I will have the class as a whole create categories/classifications of each of the objects. The class will define what a machine is. Then, the class discuss if they could function in a day without using any machine. Finally, I will introduce a visual of six different simple machines corresponding to the six different simple machine types, and ask the class to describe how they work. From their classifications, I will encourage them to further categorize the groups into the separate types of simple machines (depending on the ability of the group, I may have to give them clues.) I will ask the class to define what a machine is. Then, I will ask the class if they could function in a day without using any machine. I will introduce a visual of six different simple machines corresponding to the six different simple machine types, and describe how they work.
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	Developing the Lesson: 25 minutes 	I will discuss the following: Simple machines are just that – simple. They don't have many moving parts, and some – none at all. They are used in our lives every day from the zipper on my jacket to the computer I wrote this lesson on. When more than one simple machine is involved, it is known as a compound machine. Let's take a look at the different classifications of simple machines. There are two basic simple machines – the lever and the inclined plane: The lever consists of a board or bar resting on a pivot point (a fulcrum). A load is the object the lever moves, and the closer the load is to the fulcrum, the easier it is to move. (examples – hammer, teeter tater, shovel) The inclined plane is a flat surface that is higher on one end. This is often used to assist with moving objects from a low to high surface or a high to low surface. (examples – ramp, slide, path up a hill) Within these two classifications of simple machines there are a total of six machines: Lever: (lever, wheel and axle, and a pulley) Examples of each will be discussed and the directions of force illustrated by example a drawing of the forces on the board/overhead projector. Inclined plane: (inclined plane, screw, and a wedge) Examples of each will be discussed patent.
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	Closing the Lesson: 5 minutes	With the remaining five minutes left, I will hand out a quiz. On the left hand side of the paper there will be six different objects illustrated, one per each of the simple machines. The students will have to identify the object, identify the classification of the object associating it with a simple machine, and will have to describe the forces associated with each object.
TEACHING RESOURCES	Hammer, nail, and wood; pulley, rope, and weight; pencil sharpener; board, brick; screw, wood; axe and wood (or door stop).	
LAB SAFETY	Common safety using and handling the demonstration equipment. If the axe is permitted, no student should touch it due to possible injury.	
ACCOMMODATIONS FOR SPECIAL LEARNERS	Each of the students will be working in groups for the explore portion of the lesson. During the lesson portion, a large group class discussion will be facilitated by me. For special learners a copy of my discussion in text format will be available upon request.	

ENRICHMENT ACTIVITIES	Students will go home and take a picture of 20 items (in their home) which contain simple machines. From these 20 pictures, a collage will be made. On the collage, each picture will be labeled; the associated simple machine will be identified below the label and a paragraph describing the forces on the machine. If a student does not have access to a camera, illustrations can be made instead.
STANDARDIZED TEST ITEM GENERATOR	There will be eight illustrations on the test, six of the eight will be one each of the six simple machines, and the other two will be compound machines. Each of the simple machines will need to be labeled with the associated simple machine and a short description of the forces applied to them. On the other two illustrations, they will be compound machines. Each of the simple machines with in the compound machine will need to be labeled with a short description of the forces associated with them. The last portion of the test will ask the student to compare and contrast the six different types of simple machines, explaining the advantage of each of the simple machines. Part of the test will be a demonstration of the simple machine of the student's choice. The student can either bring in an example of a simple machine, or bring in a picture of a simple machine, and demonstrate it to the class – identifying the classification of the simple machine, and describing the forces associated with it.

VITA

Andrea Wentworth Henrie was born in Jackson, Tennessee, on August 23, 1978. Andrea received her Bachelor's degree in Elementary Education, specializing in middle school math and science, from Freed-Hardeman University in December of 1999. Andrea was awarded as the Graduate Student of Excellence. She worked as a Middle School Science Teacher after graduating from Freed-Hardeman University.

Andrea Henrie entered Freed-Hardeman University's graduate school in the spring of 2000. Andrea graduated with a Master's Degree in Curriculum and Instruction Freed-Hardeman University in 2001. Andrea worked as a Middle School Science Teacher in Brentwood, Tennessee, for four years. Andrea's responsibilities involved teaching science, reading, social studies, and serving as the science facilitator for the school.

In 2004, Andrea Henrie entered graduate school at the University of Tennessee to pursue to a Doctorate of Education concentrating in Science Education. While completing her doctoral coursework, she was employed as a graduate teaching assistant for two years at the University of Tennessee. While conducting her dissertation research, she was employed as a lecturer and research associate for two years at Vanderbilt University. Her doctoral degree in Education was conferred in May 2008.