To the Graduate Council:

I am submitting herewith a dissertation written by Sherri Lynne Brown entitled "Theory to Practice: A Study of Science Teachers' Pedagogical Practices as Measured by the Science Teacher Analysis Matrix (STAM) and Teacher Pedagogical Philosophy Interview (TPPI)." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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THEORY TO PRACTICE: A STUDY OF SCIENCE TEACHERS' PEDAGOGICAL PRACTICES AS MEASURED BY THE SCIENCE TEACHER ANALYSIS MATRIX (STAM) AND TEACHER PEDAGOGICAL PHILOSOPHY INTERVIEW (TPPI)

A Dissertation
Presented for the
Doctor of Philosophy
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Sherri Lynne Brown
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DEDICATION

This dissertation is dedicated to my parents

Mr. Bill Ross Brown

and

Dr. Carolyn Hawkins Brown

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ABSTRACT

This study continued research previously conducted by a nine-university collaborative, the Salish I Research Project, by exploring science teachers' beliefs and actions with regard to inquiry instruction. Science education reform efforts require that students learn science via inquiry. The purpose of this study was to determine and classify espoused teaching beliefs and observable teaching style. Reported are linkages between the teachers' beliefs and styles, influential coursework from College of Education and College of Liberal Arts, and outcomes of increased classroom teaching experience. Eight participants were chosen from three separate preservice science education cohorts.

An implied assumption is that teachers are able to instruct utilizing inquiry methods. Inquiry efforts require a student-centered environment as opposed to the traditional teacher-centered environment. According to the 1997 Salish I Research Collaborative, beginning teachers displayed a stark contrast between their student-centered beliefs to their teacher-centered actions. The limitations of this study were as follows: 1) the participants had completed the authentic research-based inquiry science course, *Knowing and Teaching Science: Just Do It* 2) the participants were currently teaching science at the secondary level 3) the selected instruments were used in the Salish I Research Collaborative Study, and 4) instrument validity and reliability data were not available. Selected questions from the *Teacher Pedagogical Philosophy Interview (TPPI)* instrument provided insight into beliefs concerning teacher action, student action, and teacher philosophy. Observational data using the *Secondary Science Teacher*

Analysis Matrix (STAM) provided information regarding content, teacher's actions and assessment, student's actions, resources, and environment. The qualitative interview and observational data were statistically compiled via concept maps and matrices, and then the data were represented on an ordinal scale.

Interview results indicated that 87.5% of the participants professed a teacher-centered style with regard to teacher and student's actions. Observational results indicated that 56% of the participants displayed a teacher-centered style with regard to content, teacher's actions and assessment, student's actions, resources, and environment. Additionally, 36% of the participants displayed a conceptual style during classroom observations. The conceptual style, located on the observational matrix between teacher-centered and student-centered domains, has characteristics of both domains. Linkages between the interview and observational data were unexpected due to the fact that participants professed a slightly greater teacher-centered style along the inquiry instruction continuum than what they actually practiced in their classrooms. This study reported congruity between what the participants believed and what they practiced. A slight but negligible change of inquiry beliefs and instruction was discovered among the three cohorts as years of teaching experience increased.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

In 2001 alone, genetic technological advances involved the sequence of the human genome, cloning of various animals, utilization of stem cells, and modification of crop plants (Trumbull, 2001). These remarkable genetic advances call for a scientific literacy among citizens and lawmakers in order to make informed decisions about their uses. Additional scientific phenomena in other areas of science included global warming and La Nina effects in Environmental Science, reptile population decline in Zoology, feathered reptiles and bird origination in Anthropology (Trumbull). Not only do the scientific elite experts in each field need to discuss the latest advances and phenomena, but also, everyone in society needs to possess a fundamental understanding of these advances to make informed decisions about their future.

Science for All Americans (SFAA) advocates scientific literacy for all by stating that "the world has changed in such a way that science literacy has become necessary for everyone, not just a privileged few" (Association for the Advancement of Science [AAAS], 1990, p. xvi). To obtain a scientifically literate society, *SFAA* recommends that schools "do not need to be asked to teach more and more content, but rather to focus on what is essential to science literacy and to teach it more effectively" (AAAS, p. xvi). To "teach less in order to teach it better" (AAAS, p. xvi) is a common axiom that is widely circulated in science teacher education literature. To assist science teachers with this daunting task, the National Research Council (NRC, 1996) published the *National Science Education Standards (NSES)*, a document based on the conviction that "all students deserve and must have the opportunity to become scientifically literate" (p. ix).

To assist teachers in applying the *NSES* standards and the *SFAA* recommendations, the AAAS published *Benchmarks for Science Literacy* (1993) and *Atlas of Science Literacy* (2001). The *Benchmarks for Science Literacy* (AAAS) depicts a future in which all students become scientifically and mathematically literate by "giving teachers statements of what all students should know or be able to do in science by the end of grades 2, 3, 8, and 12" (p. xi). The *Atlas of Science Literacy* (AAAS, p. vii) is a "useful tool for teachers and curriculum specialists who are attempting to develop coherent curriculum" based upon the NSES.

The *NSES* (NRC, 1996) recognizes that "everyone needs to use scientific information to make choices that arise every day" (p.1). The *NSES* (NRC) supports teaching less to teach it better; moreover, the *NSES* claims that the content the students learn is greatly influenced by *how* they are taught. In school settings, the teacher may have the opportunity to determine the science content, activities, assessment, and student interaction. All of these teachers' "decisions affect the knowledge, understanding, abilities and attitudes that the students develop" about science (NRC, p. 28). To make informed decisions, the *NSES* recommends that teachers examine their own explicit and implicit beliefs about science as they engage in professional development. Hence, the *NSES* (NRC) purports that "actions of the teachers are deeply influenced by their perceptions of science as an enterprise and as a subject to be taught and learned" (p.28).

Since Tobin and Jakubowski (as cited in Simmons et al., 1999) report that "beliefs change prior to any change in classroom practice" (p. 946), the understanding of science teachers' beliefs about content, activities, and classroom organization is essential when interpreting classroom teacher and student actions.

Understanding the beliefs that support an inquiry style of teaching in the classroom can assist teachers in actions that coincide with inquiry-based methods. Not only must teachers embrace inquiry philosophies, but they must also perform and model inquiry-based methods in their classrooms. The *NSES* Standards ask teachers to use inquiry-based scientific reasoning and processes. For instance the *NSES* Teaching Standard A states that all grade levels of science teachers should be able to plan inquiry-based science programs (NRC, 1996). Additionally, *NSES* Teaching Standard B (NRC) requires that science teachers "encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science" (p. 37).

To comply with *NSES* Teaching Standard A and B in planning and modeling inquiry, science teachers should be able to do inquiry-based science themselves. Roth (1998) argued that undergraduate college science courses do not adequately prepare teachers to perform authentic scientific research; therefore, science educators may not have the competencies needed to teach inquiry. Additionally, a *1999 Survey of Science Education Doctoral Programs in the United States* (Jablon, Lederman, McComas, & Yager, 1999) reported the current status of Science Education Doctoral Programs. This survey reported that was most students do not learn science via inquiry methods in high school or college settings. From this survey, Jablon et al. recommended that all future science educators take at least one course taught utilizing an inquiry-based approach. Given that the current *NSES* standards require science teachers to perform inquiry-based instruction, the teacher preparatory institutions need to respond by graduating future science teachers that have actually experienced authentic inquiry-based research.

Science teacher educators remain faced with the challenge of constructing a science teacher preservice preparation program that provides explicit research experiences to support them in teaching with inquiry-based methods. In providing the research experience, the science teacher educators have an expectant outcome that teachers' belief systems adopt the value of having students interact with phenomena. Various factors can and do impede inquiry-based instruction; however, the most apparent factor that impedes inquiry instruction is the graduation of science teachers who have never experienced inquiry-based research.

Statement of the Problem

Teacher preparation institutions may support inquiry-based instruction in compliance with the *NSES* (NRC, 1996) by providing various opportunities for preservice and inservice science teachers to experience authentic research. Additionally, the State Board of Education in Tennessee has licensure guidelines that recommend that "all preservice science teachers engage in an open-ended inquiry of long-term duration within their major" (State of Tennessee State Board of Education, 1997, p. 8-7). A variety of experiences, such as courses, institutes, and apprenticeships, are being designed, implemented, and evaluated as types of research opportunities where teachers may conceivably engage in authentic inquiry-based scientific research. These research experiences vary in duration, context, method, and assessment. A desired outcome of exposure to actual research protocol is for teachers to model inquiry-based science in their classrooms with their students.

Presumably by participating in the research experience, teachers achieve a range of scientific abilities and an awareness of the inquiry process, thereby giving teachers added comfort in utilizing inquiry-based methods with their students in their classrooms. After the research experience, science teachers return to their school environments to instruct according to the national, state, and local curriculum guidelines. While following these guidelines, teachers decide whether to include inquiry-based science approaches in their instruction. These inquiry-bases approaches may occur at varying levels; these approaches may be implemented immediately, a month, a year, or possibly never after the authentic inquiry-based research experience.

Determining how, when, and to what extent teachers use inquiry-based instruction can be a useful outcome for teacher preparation institutions that provide a research experience. After completing an authentic research experience, teachers may or may not have a teaching philosophy that supports implementation of inquiry-based teaching. The influence of a single research experience, regardless of its length in time, may or may not have visible consequences on teachers' actions within their classrooms. Therefore, the focus of this study was to provide data related to science teachers' philosophy of teaching and instruction with regard to inquiry-based approaches after experiencing an authentic inquiry-based research course.

Statement of the Purpose

The purpose of the study is to gather data on select inservice science teachers regarding teaching philosophy and action as related to inquiry-based teaching style. The teachers were selected because they had completed a university preservice inquiry-based research experience. The study provides links between teacher philosophy and action as related to scientific research experiences.

Research Design

Background

Undergraduate students majoring in science from a large southeastern university and who elected a career in science teaching are required to complete their four-year majors prior to beginning a year-long teaching internship. With a four-year degree in science, however, one cannot assume that the graduates have experienced authentic scientific inquiry. Roth, McGinn and Bowen's (1998) research showed that "lectures and seminars in university biology courses do not allow students to engage in scientific practice" and that "current university practices do not appear to allow preservice teachers to develop the competencies need to teach in the way the standards propose" (p. 45).

The typical science experience for these undergraduates included mass-attended lectures for content and pre-determined cookbook labs for application. Some university science courses have the lab practical as a separate course; therefore, a student could elect to complete the content lecture courses without taking the lab. The protocol for most lab experiences is to find the correct answer or to retrieve an acceptable product yield by following a set of sequential steps provided in a laboratory manual. Authentic scientific research experiences are available for science undergraduates; however, pre-med or upcoming graduate school students typically seize most of the research opportunities. An undergraduate science major can graduate without a single scientific research experience.

To counter the research deficiency in preparing future science teachers, two faculty members in the College of Education and the Division of Biology at this large southeastern university collaborated to design a course for the preparation of preservice science teachers by providing an intensive research experience. Biologist/geneticist, Leslie G. Hickok, and science teacher educator, Claudia T. Melear designed the experiential research course. Following the inception of the research course five years ago, over fifty preservice science teachers have been involved in the inquiry-based research course.

Research Course Evaluation

Various formative and summative assessment measures have been utilized to ascertain the outcomes and value of the research course experience (Hickok, Warne, Baxter, & Melear, 1998; Melear, Goodlaxson, Warne, & Hickok, 2000). Video interview, laboratory journal, reflective journal, audio interview, and classroom observation are all forms of collected data utilized for analysis and evaluation of the research experience.

All research participants kept a laboratory notebook, and a sample of these notebooks was analyzed utilizing a course-specific rubric for inscription analysis described in Lunsford & Melear (2002). Hickok, the science instructor of the inquiry investigative course, kept a journal during each course session. Hickok reported in 2002 his thoughts and actions over the past five years while instructing the research course (Lashley, Melear, & Hickok, 2002). A pending case study dissertation will provide a complete analysis of the data gathered from Hickok's journals and interviews (Lashley, in progress).

While enrolled in the research course, students were videotaped during interviews before and after course completion. The interview questions were directed at discerning students' ideas and conceptions about experimental and scientific processes. As part of a science methods course requirement, students videotaped their classrooms and then analyzed their teaching utilizing the *Secondary Teaching Analysis Matrix (STAM)* instrument (Gallagher & Parker, 1995) from the Salish I Research Collaborative (1997), or the Interstate New Teacher Assessment and Support Consortium (n.d.) performance-based portfolio. Subsequently, to determine implementation of inquiry-based practices in their classrooms, interviews were conducted with students who had taken the course and who were currently teaching (Suters, Melear, & Hickok, 2002). Both the interview and observational data available prior to this investigation were self-reported data by the participants in the research course.

Simmons et al. (1999) reported on beginning teachers' beliefs and actions, stating that even though the "teachers may believe strongly in student-centered approaches to science teaching, they do not translate these beliefs in practice (the gap between belief and action)" (p. 946). This result then suggests that self-reported data about inquiry instruction may lack validity when teachers are asked to respond about their beliefs and practice. Independent outsider observational data of the classrooms of students who had completed the research experience was not gathered in this study.

Students who had taken the research course offered at the large southeastern university were typically available for feedback during their internship year. Upon graduation, students would lose contact with the university due to employment in a full-time teaching position. As Simmons et al. (1999) reported as "teachers participate in the social milieu of a classroom, he or she constructs specific contexts in which to function" (p. 246). Therefore, in order to sufficiently address the degree of transference of the inquiry-based research experience to the classroom, teachers with various years of teaching experience in various settings are required.

Study Population

The study population included three separate Cohorts that had completed the inquiry-based science course. Eight students had graduated as Cohort 1, eight had graduated as Cohort II, and eleven had graduated as Cohort IV.

Cohort III was not represented in the study. Due to course scheduling conflicts, six students of Cohort III did not take the authentic inquiry-based course. In lieu of the course, those six students participated in a semester-long research apprenticeship with a practicing scientist. The remaining Cohort III student taught in a non-traditional educational facility on an island located off the coast of Savannah Georgia.

For selection to participate in the study, each Cohort member was currently teaching in the secondary school setting within a reasonable driving distance to the university. Overall, eight participants met this qualification. Two participants were chosen from Cohort I, three were chosen from Cohort II, and three were chosen from Cohort IV. The participant number was lower than the total individual Cohort number due to teacher unavailability, i.e., teachers leaving the teaching profession and/or relocating to another state.

Research Questions

Four research questions were developed to serve as the framework for the investigation:

1. What are the philosophical tenets of beginning teachers with regard to inquiry instruction?

2. How have these same teachers' practices and beliefs been influenced by the University of Tennessee science teacher preparation program?
3. What are the teachers' observed practices in the classroom? How do they align with inquiry instruction?
4. Are teacher's actions consistent with their philosophy of teaching? Are there measurable differences in the presence and quality of inquiry instruction among the three different cohorts within the classroom?

Methods and Procedures

The research design met the criteria for a "Mixed Methodology IV" study (Tashakkori & Teddlie, 1998, p.57). The research questions were exploratory, the collected data was qualitative, and the analysis was statistical. The three instruments chosen for the study were used in the 1997 Salish I Research Project. The *Teacher Pedagogical Philosophy Interview (TPPI)* instrument was used to obtain teachers' philosophical beliefs; while, the *Secondary Science Teacher Analysis Matrix (STAM)* was used to obtain teachers' classroom actions. Demographic information was obtained from the *Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP).*

Each participant responded to fourteen *TPPI* questions regarding teacher's actions, student's actions, and teacher philosophy. All interview questions were transcribed and each question was coded utilizing the instrument-provided concept maps.

The codes were then placed on a Supercode matrix under the following style categories: didactic, transitional, conceptual, early constructivist, experienced constructivist, and inquiry constructivist.

Each participant was observed and videotaped for three hours of classroom instruction. Both the researcher and assistant had previously trained each other in utilizing the *STAM* observational rubric. After the researcher and assistant observed each of the participant's instruction, they coded each teacher's style individually on the *STAM* grid. The twenty-two subcategorical *STAM* codes were placed under the following style categories: didactic, transitional, conceptual, early constructivist, experienced constructivist, and inquiry constructivist. The researcher and assistant's codes were compared for inter-rater reliability for each participant's *STAM* item.

The interview data provided insight into beliefs concerning teacher's actions, student's actions, and teacher's philosophy. The observational data provided information regarding content, teacher's actions, student's actions, resources, and environment. The qualitative interview and observational data were compiled and represented on an ordinal scale. Teacher's beliefs, teacher's actions, and the linkages between beliefs to action were analyzed. University coursework reported as unbeneficial and beneficial in preparing to teach was given. Additionally, comparisons among cohorts with regard to teaching practice and style were provided.

Assumptions of the Study

The following assumptions underlie the study:

1. Participants were sincere in answering interview questions.
2. Participants displayed their usual instructional practices during videotaped sessions.
3. Interview and observational data obtained from beginning teachers reflect what they have learned to value in their preparation program.
4. Relationships with participants before the study did not influence the results of the study.
5. Differences in timing of observations did not influence teacher actions and beliefs.
6. The two raters were trained similarly concerning interpretation of the *STAM* observational instrument rubric
7. The coding of the *TPPI* interview and *STAM* observational data was performed accurately according to the Standard Operating Procedures provided in the Salish I Research Project Supplement.

Limitations of the Study

The following limitations underlie the study:

1. Participant numbers were limited to students who had completed the Botany 531 *Knowing and Teaching Science: Just Do It* course at the University of Tennessee.

2. Participant numbers were limited to those who were currently teaching science in a middle or high school located within a 50-mile radius from the University of Tennessee.

3. Instrument selection was limited to the Salish I Research Collaborative study.

4. Data validity and reliability were limited to instrument validity and reliability; current validity and reliability data were not available for any of the three instruments.

Importance of the Study

This study examines the implementation of inquiry-based teaching methods after the completion of an authentic inquiry-based course. An idea for the shortage of inquiry-based science teaching in the school setting is that teachers do not possess the skills required to use inquiry research-based methods (Roth, 1998). By providing the research experience, teacher preparation institutions aspire to bridge the gap between the inquiry-based theories and practices advocated in the university setting and the actual beliefs and practices of science teachers in the school settings.

The 1997 Salish I Research Project underscored the need for teacher preparation institutions to determine outcomes of their programs. The nine-university Salish Research Project designed and piloted multiple instruments to measure teaching style regarding inquiry-based instruction. These instruments were considered a contribution to collaboration in the science and math education fields, because they provided a common language among various institutions.

As a result of the Salish I Research Project, research efforts from varying institutions have continued by using the Salish instruments to gather data and compare findings regarding teacher preparation institutions (McGlamery & Fluckiger, 2001; Adams & Krockover, 1999; Waggett, 1999). These researchers embraced the charge from the Salish I Research project to continue research of beginning teacher's beliefs and actions as related to inquiry-based instruction. As stakeholders in science teacher education reform efforts, it is imperative that teacher preparation institutions continue to determine outcomes of their teacher preparation coursework. This study seizes the opportunity to provide additional observational and interview data regarding inquiry instruction among inservice teachers that had completed a teacher preparation program that included an inquiry experience.

Definition of Key Terms

Authentic – the learner engages in activities in the classroom that are similar to what the learner does in life outside of the class

Authentic science – learners engage in classroom science activities that have a "large degree of resemblance with the activities in which core members [or scientists] of a community actually engage" (Roth, 1995, p. 29)

Constructivist – one who organizes experiences to create conceptual frameworks that “make sense” to him/her

Hands-on – manipulation of materials

Inquiry – “multi-faceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and use of critical and logical thinking, and consideration of alternative explanations” (NRC, 1996, p. 23)

Inquiry-based – investigative aspect of science where the learner manipulates/“tinkers with” and observes phenomena; identifies a question; designs and conducts an investigation; gathers, interprets, and analyzes data; uses experimental evidence to develop explanations and predictions; and reports results

Intern – university graduate student completing a year-long university licensure requirement involving pedagogical practice under the tutelage of a science teacher in a secondary school setting

Investigative-based – sharpened or redefined question(s) requiring a course of action or plan of experimentation for exploration into phenomena; this plan may be altered in response to experimental data

Laboratory inscription – any record (written or computer-generated) associated with a laboratory research project, such as but not limited to drawings, graphs, tables, lists, photographs, numerical data, questions, calculations, experimental methods, calculations, text, figures, equations, and charts; inscriptions contrast mental representations because they are public, available, primary social objects (Roth & McGinn, 1998, p. 37)

Philosophy of teaching – the teacher's beliefs about the nature of teaching and learning (Simmons et al., 1999, p. 935)

Research experience – opportunity to engage and perform an experiment within a laboratory setting

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

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)

Student action – "the nature and purposes of students' writing; the nature and frequency of students questions; the nature of student-student interactions; the nature and existence of student initiated activities; and the students' understanding of and response to teacher expectations" (Simmons et al., 1999, p. 935)

Teacher action – "the number and kinds of teaching methods used; the nature and frequency of labs, demonstrations and hands-on activities; the nature of teacher-student interactions; and the nature of the teacher's questions" (Simmons et al., 1999, p. 935)

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 the definitions of key terms. Also included in Chapter One are the background, evaluation, population, research questions, and methods and procedures.

Chapter Two contains a review of the literature and is reported in four sections. The sections are: the rationale for inquiry instruction, university approaches to authentic research, applying university theory to practice, and previous research on teacher preparation programs. Chapter Two also includes an overview and outcome data from two national studies of teacher preparation programs.

Chapter Three describes in depth the research design. It contains sections on rationale and methodology, research context and participants, questions and method, and data analysis. Inter-rater reliability percentages between the researcher and assistant are provided for each participant's *STAM* analysis.

Chapter Four reports the study's findings. It contains sections reporting demographic data, interview data, and observational data. Data from each participant's interview and observation is shown in tabular and graphical formats. Comparisons of professed and observed teacher's actions and student's actions are provided. Analyses of overall findings are provided.

Chapter Five closes with conclusions, discussions, and implications for further research based upon the study findings.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter describes a literature review conducted on inquiry-based experiential research experiences for teacher preparation and teacher professional development. The types of approaches that provide inquiry-based research experiences to science teachers are presented under the following headings:

(1) Inquiry Instruction

(2) University Approaches to Authentic Research

(3) Theory to Practice

(4) Research on Teacher Preparation Programs

(5) Chapter Summary

Inquiry Instruction

Shymansky and Yore (1980) reported that during the 1960 and 1970 decades the terms "inquiry" and "discovery" teaching/learning strategies were used synonymously. A science teacher was expected to use the "discover method" in his/her classroom as part of the current science education reform effort or risk being labeled a traditional or old-fashioned science teacher (Shymansky & Yore). To assist science teachers in developing appropriate discovery activities, Morine and Morine (1973) developed an instructional model focusing on the student's cognitive development level as related to learning activities. This instructional model described three types of discovery methods (structured inductive, semideductive and hypothetico-deductive) as related to student's minimal cognitive development (Morine & Morine). The cognitive dimensions of the model adhered to Piaget's developmental model (Piaget & Inhelder, 1969).

The Morine and Morine (1973) model defined the structured inductive and semideductive discovery methods as requiring concrete thought; while, the hypothetico-deductive method required forced operational thought. The concrete thought processes included learner objectives involving concepts, categories, and properties. The formal thought processes included learner objectives involving deductive inquiry, hypothesis formation, and experimentation.

By utilizing the Morine and Morine (1973) instructional model, Shymansky and Yore (1980) examined "student performance in classrooms where lesson structure was deliberately varied across topics [to] reveal clear differences between those students to whom the structure is matched and those to whom it is not" (p. 369). Via interview, quiz, and laboratory-performance data derived from 77 undergraduate elementary education majors, Shymansky and Yore indicated that

> hypothetico-deductive activities may have the added benefit of encouraging persons to use a hypothesis testing approach by as simple a means as providing directions to use such an approach and teasing the nonformal learner into using a hypothesis prediction-comparison approach which approximates formal thought. (p. 380)

Therefore, Shymansky and Yore suggested that students do not simply need to *practice* hypothesis testing at the direction of the teacher. The teacher needs to challenge the students to *generate* their own hypothesis from their observations.

Currently, included within the National Science Education Standard's (NRC, 1996) inquiry definition, a student is expected to pose questions from observing phenomena. "Inquiry" defined by the NSES (NRC) is

> a multi-faceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and use of critical and logical thinking, and consideration of alternative explanations. (p. 23)

Therefore, to comply with NSES inquiry standards, science teachers should provide students opportunities to engage in activities where researchable questions can be posed and experimentations can be implemented. In order to provide students with research opportunities using hypothetico-deductive reasoning, teachers themselves must be exposed to formal thought processes by engaging in authentic research activities.

University Approaches to Authentic Research

Teacher preparation programs have utilized three varying approaches to offer preservice teachers inquiry-based research experiences. These three approaches, as defined by the preparation institution, included an institute model, an apprenticeship model, and an inquiry course model. To provide an inquiry-based research experience, science teacher educators have collaborated with scientists in offering various institutes (Gilmer, Hanh, & Spaid, 2002; Granger, 2002; Westerland, Schwartz, Lederman, & Koke, 2001; Schwartz, Lederman, & Crawford, 2000; Hemler, 1997; Pyle et al., 1997; Spiegel, Collins, & Gilmer, 1995; Gottfried, 1993). The following science teacher preparation institutions offered inquiry-based summer institutes: Oregon State University, Southwest Texas University, West Virginia University, Florida State University, and University of Missouri/St. Louis. The University of Tennessee was the only reviewed institution that implemented a semester-long apprenticeship model with a scientist (Brown & Melear, 2002). The third approach, the inquiry course model, was implemented for preservice science teachers to experience authentic research in various subject areas, which included botany, astronomy, and physics. Those institutions altering science courses included Georgia State University, Bowling Green State University/Ohio, and the University of Tennessee (Wilson & Lucy, 2002; Van Hook, 2002; Melear et al., 2000).

These three types of research experiences provided preservice and veteran science educators the opportunity to experience authentic inquiry-based scientific research. Presumably, by participating in an authentic research experience science teachers were exposed to an environment where the following aspects of scientific research occurred:

1) devising a researchable question
2) determining materials for research
3) collaborating with fellow scientists
4) evaluating previous research from a variety of sources (i.e. journals, texts, websites)
5) preparing and maintaining experimental designs
6) troubleshooting problems and concerns
7) maintaining notebook of data/inscriptions

8) controlling variables
9) transforming data to tabular and graphical forms
10) presenting research in oral and/or written formats

Institute Model

One possible method that affords preservice or inservice teachers an inquiry-based research experience is the institute model. The institute model is shorter in duration than the apprenticeship model and is frequently referred to as a summer workshop by program designers. Teacher preparation institutions that have implemented the institute method included Oregon State University, Southwest Texas University, West Virginia University, Florida State University, and University of Missouri/St. Louis (Gilmer, Hanh, & Spaid, 2002; Granger, 2002; Westerland, Schwartz, Lederman, & Koke, 2001; Schwartz, Lederman, & Crawford, 2000; Hemler, 1997; Pyle et al., 1997; Spiegel, Collins, & Gilmer, 1995; Gottfried, 1993). The institute models vary in duration from two weeks at West Virginia University to three and ten weeks at Oregon State, to five weeks at Florida State University, to six weeks at University of Missouri/St. Louis, to eight weeks at Southwest Texas.

Oregon State University

At Oregon State University, thirteen preservice teachers spent an average of five hours per week during a ten-week term in a research setting with a scientist who was actively conducting research at the university. Involvement within the research experience varied; however, the premise was to expose the preservice teacher to "research conducted in as authentic a manner as possible" (Schwartz et al., 2000, p. 20).

The scientists "were asked to welcome the intern into his/her research setting; discuss the purposes, background, techniques, and direction of the research agenda; and involve the intern in a project if possible" (Schwartz et al., pp. 20-21). The interns were asked "to observe and interact with the other researchers in the setting, and engage in a project if possible" (Schwartz et al., p.21). The interns discussed and reflected on the research experience by writing in reflective research journals and by attending five 2-hour seminars. The results illustrating the interns' involvement ranged from "highly inquiry-oriented experiences that included designing and conducting an investigation . . . to limited inquiry that included observations and discussion within the research setting" (Schwartz et al., 2000, p. 26).

Schwartz (2000) and her colleagues conducted a study of the program in which they measured the Nature of Science (NOS) beliefs – not inquiry abilities. They analyzed interviews, reflective journals, data journals, participant observations, and pre- and post-questionnaires. Their overall finding "suggested [that] the perspective held by the intern is perhaps the most critical factor in determining the learning outcomes in regard to NOS" (Schwartz et al., p. 25). Even though most of the participants did not design and conduct their own independent investigation, the results indicated their NOS views were enhanced. However, the researches' results still supported the claim that "'doing science' is insufficient for one to understand adequately the NOS" (Schwartz et al., p. 37).

As part of *Project ICAN: Inquiry, Context and Nature of Science* at Oregon State University, inservice teachers spent three weeks, instead of ten, in a summer institute. The first two-week period consisted of ten four-hour sessions in a research lab experience. The participants completed journals about their experiences and participated in daily whole-group seminar discussions. The third and final week of the workshop focused on "teachers developing lessons and practicing teaching NOS in an explicit manner within the context of inquiry-based science activities" (Westerland et al., 2001, p. 6). Westerland et al. study's results concurred with the previous study in that the same NOS conceptions appeared. As stated earlier, these particular studies were not measuring inquiry capabilities; however, they were examples of attempts to incorporate an authentic science experience into teacher preparation programs.

Southwest Texas University

Additionally, the *ICAN* model was used as part of a summer institute for inservice secondary science and math teachers titled *Science/Math/Technology Education Institute, SMTEI* (Westerland et al., 2001). *SMTEI* of Southwest Texas University included goals to provide "teachers with a research experience; to provide practical mechanisms for transfer of research experiences to classroom teaching; to develop new teaching exercises based on these experiences; and to establish long-term associations between science teachers and the research community" (*SMTEI: Science/Math/Technology Education Institute*, 2001, p.1). By participating in the institute, inservice teachers spent eight hours a day, five days a week for eight weeks in an authentic research setting. The participants completed journal writings guided by research questions. Weekly the participants debriefed their experiences with "each other, a science educator, two scientists and a high school teacher"(Westerland et al., p. 6). Of the previous institute models, "participants in this program engaged in the most authentic scientific inquiry . . . [however], most *SMTEI* participants maintained relatively naive conceptions aspects of NOS" (Westerland et al., p. 6).

An in-depth analysis of the *SMTEI* eight-week research experience detailed the manner in which the authentic scientific summer research experience provided five features of scientific research as defined by *Science For All Americans* (Westerland, Garcia, Koke, Taylor, & Mason, 2002). The features Westerland et al. investigated were:

1) the process of formulating and testing hypotheses,
2) the development of an experimental or descriptive design,
3) the obtaining of evidence by observations and measurements taken in situations that range from natural setting to contrived settings,
4) the use of logic and creative insight in the analysis of data,
5) and the development of an explanation that is based on valid observations. (pp. 74-75)

Westerland et al. investigated 23 of the teachers' research experiences by reviewing the following teacher submitted materials: daily journals of laboratory work, lesson plans incorporating research experience, and completed pre- and post- content tests. The researchers interviewed the teachers weekly, conducted focus group meetings, and observed teacher presentations.

Westerland et al. (2002) reported that "all of the experiences did possess some of the features" (p. 75). All of the research experiences included Feature 2 (the development of an experimental or descriptive design), and Feature 3 (the obtaining of evidence by observations and measurements taken in situations that range from natural setting to contrived settings). Two-thirds of the research experiences included Feature 4 (the use of logic and creative insight in the analysis of data), and Feature 5 (the development of an explanation that is based on valid observations). Only one research experience included Feature 1 (the process of formulating and testing hypotheses).

Only one of the fifteen mentoring scientists expected the teachers to write a research proposal; therefore, "most of the teachers did not formulate hypotheses" (p. 74). After viewing and analyzing teachers' daily journals, transcribed interviews, research presentations, *transfer activities*, knowledge-based tests, and classroom observations, Westerland's et al. (2002) conclusions purport "that a professional developmental model of prolonged engagement in research activity can be successful at promoting teacher change towards more inquiry teaching" (p. 79).

West Virginia University

West Virginia University (WVU) and the *National Radio Astronomy Observatory (NRAO)* at Green Bank, WV were sites for an inquiry-based research experience (Pyle et al., 1997). This model placed preservice and inservice teachers in a one to two-week summer research institute at *NRAO*. Teachers conducted inquiry experiments with available science mentors and observatory equipment. From a generalized research problem, the teachers formulated research questions, collected and analyzed data, and presented the data to the group. After the institute experience, the teachers planned, developed, implemented, and evaluated an inquiry-orientated scientific investigation for their classrooms. Table 1 summarizes how teachers implemented research experiences for their students after the *NRAO* program. To reinforce the *NRAO* research experience, teacher educators utilized inquiry methods in their methods courses. Lastly, to increase the research transference into the classroom, every attempt was made to place the preservice science teacher with a mentoring teacher who was a previous Green Bank institute attendee.

Hemler (1997) examined the *NRAO* experience by researching the effectiveness of transference from the preservice research component to the science classroom. Hemler stated "of the seven pre-service teachers observed, five initiated research experiences [that] were consistent with the research experience model as presented by Green Bank" (p. 172). "Five projects of the seven implemented by participants were considered successful research experiences for the students" (p. 157). Hemler attributes the success of these five to the positive influence of the cooperating teacher. Overall, Hemler's study contended that the astronomy laboratory institute remains an "exemplary preservice training model … is unique [in its] approach to constructivist research … [and] is effective in exposing preservice teachers to science research" (p. 183).

Table 1

WVU and NRAO Teacher Implemented Research Projects and Student Activity

Teacher Implemented Research Experience	Student Research Activities
Teacher presented self- selected student-paired partners with 5 unknown solutions. Students determined unknowns with tests including solubility, flame tests, conductivity, pH, and color	Observed, recorded data, classified, predicted, asked questions, tested variables, drew conclusions, presented results, consulted with other groups, explained unexpected results; struggled with problem; exhibited anxiousness and being overwhelmed; constructed tables/charts; selected partner
Teacher asked students in groups of 3 to choose organism from list (crayfish, beta fish, fiddler crabs or guoramis) and observe behaviors of these organisms. Teacher asked students to develop experiments to do with their organisms to investigate these behaviors. Observations could include organism habitat, mating rituals, and/or fighting.	Observed, researched background information, recorded observations, constructed posters, presented results, quantified results (one group), described observation; determined substrate fiddler crabs and crayfish preferred; observed behavior of confronting male beta fish through glass window
Teacher asked student groups of 4 to 5 to develop a list of factors which affect plant growth. Teacher provided information on terms such as control, constant, hypothesis, trials, quantitative and qualitative.	Selected groups; selected parameter; completed proposal form Affecting Plant Growth, predicted results, wrote methodology, wrote objective of study, observed plants daily, recorded plant measurements, explained and presented results, tested effects such as soil type, growing space, pH, light variability, fertilizer, water variability on plant growth, graphed data (one group), drew conclusions, rejected or accepted hypothesis

Table 1 (continued)

Teacher Implemented Research Experience	Student Research Activities
Teacher asked students to conduct library research of 13 questions regarding hydroponics. Teacher took groups of 4 students to greenhouse to observe hydroponics setup. Teacher asked students "How do we get plants to float?" Teacher discussed variables and experimental design. Teacher set up plants under differing nutrient conditions.	Researched in library, answered teacher guided questions, wrote 2-3 page literature review from library research, identified variables (various micro and macro nutrients), identified parameters (height, color, number of roots and leaves), observed plants; wrote research paper
Teacher divided class into 3 groups of seven students and introduced students to various types of algae. Teacher described eutrophication and phosphates and then gave a different phosphate solution to each group and asked students to dilute to ½. Teacher discussed the scientific method and prompted them to define the problem they were investigating. Teacher discussed lab report.	Followed lab handout, diluted solution as prescribed by lab, wrote materials and procedure from lab handout, observed cultures, recorded data, classified, asked questions, ½ the class not involved, exhibited curiosity, frustration, persistence, constructed graph and table, presented results
Teacher divided class into 5 groups of 7 based on sex, discipline, and ability. Teacher introduced topic of investigating the seasons by giving the students a problem statement.	Researched in library, viewed filmstrip, completed worksheet, 7 students out of 26 presented results voluntarily, wrote 1-2 page report, drew diagrams from books, gave textbook explanation, presented some misconceptions

Source: Table information summarized from pp. 141-155 of Hemler, D.A. (1997). Research experiences in teaching preparation: Effectiveness of the green bank preservice teacher enhancement program. (Doctoral dissertation, West Virginia University, 1997). *Dissertation Abstracts International, 58*, 07A.

Florida State University

The Florida State University program *Science For Early Adolescence Teachers (Science FEAT)* utilized the institute model for inservice middle school science teachers in North Florida and South Georgia (Spiegel et al., 1995). It was reported that these particular middle school science teachers had never "engaged in the practice of science nor fully understood what scientists do" (Spiegel et al., p. 169). *FEAT*'s institute model involved 15 research facilities and provided 25 research opportunities, supporting a possible 81 placements. The *FEAT* science teachers "spent 75-100 hours during five weeks engaged in some aspect of research at a level beyond that of a technician. Also, each group produced a publishable quality abstract and presented a poster of their research" (Spiegel et al., p. 169). With regard to the poster quality, one participating scientist responded that he "could have taken any of those posters to a regional American Chemical Society meeting" (Spiegel et al., p. 170).

Recently, Gilmer, Hahn, and Spaid (2002) have launched at Florida State the program *Collaborative Opportunities-Learning Experientially And Research uniting Educators and Researchers of Science* (*CO-LEARNERS*) to provide preservice teachers experience in conducting research. Eight preservice science teachers were paired with a practicing scientist during the summer "to experience the process of science and scientific inquiry first-hand" (Gilmer et al., p. 8). This experience enabled the "preservice teachers to see science as [it] is actually conducted" (Gilmer et al., p. 11). Gilmer et al. tested "this type of nontraditional laboratory to see how the teachers enjoyed it, what they learned, and how they implemented what they learned in their classrooms" (p.11). Common themes that emerged from the experience included learning science content, valuing collaboration, and utilizing technology. Modifications to the program that have been made after the first implementation of the summer research program included: 1) a written report requirement in addition to the final presentation, and 2) a two scientist assignment per teacher instead of one (Gilmer et al.).

University of Missouri/St. Louis

The *Students and Teachers as Research Scientists (STARS)* program at the University of Missouri/St. Louis was a six-week summer institute involving inservice or preservice teachers, high school students, and science researchers (Granger, 2002). Granger reported that the science teacher and students had the opportunity to perform research in

> anthropology, astronomy, biology, chemistry, computer science, earth science, engineering, mathematics, physics, or psychology at one of following collaborating institutions: St. Louis University, Washington University, University of Missouri, Food and Drug Administration, Monsanto Company, Boeing Corporation, and the Army Corps of Engineers. (p.1)

Science teachers participating in the *STARS* program had the opportunity to perform research under the supervision of a research mentor. The teachers applied "various problem solving strategies to independent research projects, wrote technical reports, and orally presented their results in a seminar format" (Granger, p. 1).

Gottfried (1993) conducted an in-depth formative evaluation of the *STARS* program utilizing pre- and post- interviews and a science activity checklist. Gottfried reported that the participating *STARS'* teachers received a "substantial amount of experience in scientific research and design and experimentation" (p. 14). The teachers valued the *STARS* experience and felt the *STARS* program enhanced their scientific knowledge, increased their scientific ability, and positively impacted their laboratory classroom curriculum. However, the results of the classroom activity checklist and questionnaire on teaching strategies did not reflect an increased usage of laboratory-oriented strategies in the classroom (Gottfried).

Apprenticeship Model

The apprenticeship model involves a greater amount of time and involvement in the process than the aforementioned institute models. The *United States Department of Labor* (n.d.) defined an apprenticeship as "a combination of on-the-job training and related classroom instruction in which workers learn the practical and theoretical aspects of a highly skilled occupation" (p. 1). In the educational realm, an apprentice method is defined as "a plan of instruction whereby an inexperienced performer or worker is matched with one or more experienced, well-qualified workers for learning skills and competencies in a vocation or profession" (Good, 1973, p. 35). As the novice works alongside the master practitioner, the novice is subjected to the "traditions of sharing and collaborating in the doing and being subjected to the judgments and criteria eminent in the interactions over an extended period of time" (Layton, 1990, p. 775).

The apprentice novice/expert model is grounded within current science education research (Duit & Treagust, 1998). It is believed that through "the apprenticeship model, the novice learner gets to be an expert through the mechanism of acculturation into the world of the expert" (Duit & Treagust, p. 7). When the novice preservice teacher enters the scientific laboratory of the expert scientist, the research experience is authenticated in a manner that educational methods or traditional science courses cannot replicate.

University of Tennessee

The University of Tennessee offered an apprenticeship science course during the Spring 2002 semester. The course was designed to meet the September 2, 2001 Tennessee licensure guidelines component that "all preservice science teachers will engage in an open-ended inquiry of long-term duration within their major" (State of Tennessee State Board of Education, 1997, p. 8-7). The course was developed to meet the state guideline for those preservice teachers who were unable to enroll in the research course *Knowing and Teaching Science, Just Do It* (Melear et al., 2000). During the 15-week semester course, the six preservice teachers spent at least nine weekly hours with the scientists in the laboratory conducting research. The preservice teachers met six times for a round-table discussion of their research with the science educator leading the course. During the apprenticeship experience, the preservice teachers logged raw data, transformed data, explained results, and wrote reflections. A final symposium was held at the end of the semester in which preservice teachers presented their research results to all of the participating scientists and preservice teachers. Table 2 lists each teacher's presentation topic. Interviews of three participants depicted varying results on implementing inquiry into the classroom during the year of internship following their apprenticeship in scientists' laboratories (Brown & Melear, 2002).

Inquiry Course Model

The inquiry course model places preservice teachers as students within an authentic inquiry-based laboratory setting. The preservice teachers learn science content from a

Table 2

University of Tennessee Spring 2000 Preservice Teacher Apprenticeship Research Presentation Topics

Topic Title
Kanamycin Production from Streptomyces kanamyceticus
Hands-on Inorganic Chemistry
Knockdown Resistance to Carbon Dioxide in Three Stocks of Drosophila melanogaster used in DDT Research
Echolocation Calls of the Mexican Free Tailed Bat (Tadarida brasiliensis) at High Altitudes
Effects of Shade Treatment on Rhizome Growth of Helianthus eggertii (Asteraceae) Recombinant Phage Antibody System
Distance Test for Catilipsis of Agelenopsis aperta

veteran faculty science professor who conducts the class using cooperative groups, material manipulation, knowledge construction, oral presentations, rubric grading, and open-ended experimentation. The reviewed inquiry-based courses varied within the content areas of biology, astronomy, and physics. Courses that model science by inquiry for pre-service teachers are offered at the University of Tennessee (UT), Georgia State University, and Bowling Green State University/Ohio.

University of Tennessee

The preservice science teacher course, *Knowing and Teaching Science, Just Do It*, at UT included preservice science teachers performing authentic scientific research. This course, taught by a botanical geneticist, was modeled upon authentic inquiry in determining an unknown substance (Melear et al., 2000; Hickok, et al., 1998). The students were presented with an unknown and they hypothesized, experimented, and presented results concerning this substance. The students elected to work collectively or independently as they began their journey in determining the scientific unknown. For many science undergraduate students, this was the first opportunity at true investigative inquiry-based science. Most students enrolled in the course *Knowing and Teaching Science, Just Do It* stated that their previous experience in science courses afforded opportunities to hear lectures and perform pre-established cookbook labs (Hickok et al.; Melear, et al.). During the course, the students performed at least two extended inquiry investigations from self-selected questions where the students, and occasionally the instructor, did not know the answer. At the end of the course, each student brought in materials and a lesson plan and taught a mini version of an inquiry lesson they would use in their classroom. This course is further detailed in Chapter III.

Georgia State University

Wilson and Lucy (2002) from Georgia State University became interested in the *Knowing and Teaching Science, Just Do It* inquiry course method following Melear's presentation at the 2000 southern Association for the Education of Teachers in Science (AETS) conference. Both Wilson and Lucy visited UT's *Knowing and Teaching Science, Just Do It* class session in April 2001 to observe and interview the current ten participants. They also interviewed Melear, Hickok, and the researcher about the assignments and protocol of the course. Wilson and Lucy (2002) implemented an inquiry-based astronomy course at Georgia State Univsersity for teachers to experience authentic research, and John Wilson presented the results of their first attempt results at the national 2002 AETS conference. Wilson found his students excited to be involved in authentic research, working well as a group to accomplish a goal, and having an unforgettable Dewian experience. His course constraints included lack of time for the actual observations, star selections, and final projects. He plans to offer the course again in Summer 2002.

Bowling Green University

At Bowling Green University in Ohio, Van Hook (2002) has teamed with science teacher educators and classroom elementary teachers in designing an introductory course titled *Physics 101: Introduction to Physics Middle Childhood Educators*. Some of the collaborations were initiated by the *Toledo Areas Partnership in Education: Support Teachers as Resources to Improve Elementary Science (TAPESTRIES)*. This course was designed to address the science education needs of future elementary and middle school teachers. The course lecture and laboratory sessions were combined and included the following objectives: investigating physical phenomena; connecting different areas of physics; writing investigative reports; presenting orally; and leading group agendas. Van Hook's teaching methodology embraced constructivist practices in which he does not simply transmit information for the students to repeat on exams. The student's goal is "not to figure out the correct answer (or guess what answer the [instructor] wants you to come up with), but to honestly think about the question and to interact with the materials with an open and inquiring mind" (Van Hook, p. 3). The assessment in the course is rubric-based situated in a supportive, non-competitive environment.

In conjunction with the manipulation of materials in learning science content of work, force, energy, magnetism, simple machines, complex machines, the preservice students had outside teaching requirements (Van Hook, 2002). The course teaching requirements were: (1) the students teach their developed lessons to 4th/6th graders, and (2) the students select to participate in *two* science education professional development activities. The students selected from the following professional development options: the *TAPESTRIES* symposium, where they learn about teaching science; working at the science day at the library, where they teach with science activities; or doing online journaling, where they discuss science teaching. One option that was available during the Fall 2001 semester was that students could help teach sessions at the *Women in Math & Science Day* for junior high girls. Lastly, the students completed a science teaching project, which involved the following: researching the subject/topic; aligning that topic with the educational standards; writing a "5E" (Trowbridge & Bybee, 1990, p. 333) lesson plan for the topic; developing a graphic organizer; creating cross-curricular activities; creating/finding assessments for the topic; and creating a concept map of understanding of the topic (Van Hook, 2002).

Summary

The provided descriptions of teacher preparation research experiences are by no means an exhaustive list. Regardless if teacher preparation programs offer an institute, apprenticeship, or inquiry course, they all have the same overarching goal – providing preservice and/or inservice teachers an authentic inquiry-based research experience. From that experience, preparation institutions expect that teacher's beliefs about scientific processes and teacher's skills about experimentation will be altered from teacher-centered methods to more inquiry-based methods. With that goal accomplished, science teachers will have the belief systems and skills to comply with the *NSES* standards (NRC, 1996) in performing and modeling authentic inquiry-based in their classrooms. From the initial findings and results reported in evaluations of the previous institutes, apprenticeship, and course models, various elements of authentic inquiry are present while various elements are not. (Brown & Melear, 2002; Gilmer, 2002; Westerland, 2001; Schwartz et al., 2000). Additionally, various levels of transference of the research experience into the classroom were reported (Hemler, 1997; Gottfried, 1993).

Theory to Practice

An underlying concern of science teacher educators is to determine the effectiveness of course instruction to student accomplishment of course objectives. The previously cited laboratory institute, apprenticeship, and inquiry-based courses had a consistent objective in providing teachers with experiential learning that will enhance their ability to use inquiry-based research methodologies in their classrooms. Invariably, students differed in their achievement of this objective. Science teacher educators and scientists used traditional and alternative assessment measures to determine if course objectives were met. Assessment measures included application of rubrics and tests, along with analysis of lesson plans, presentations, laboratory reports, inscription notebooks, reflective notebooks, and instructed lessons.

Science teacher educators and scientists utilized these assessment tools to determine student capabilities and progress in accomplishing the noted course objectives. During the actual inquiry research, the teacher educator or scientist measured usage of scientific equipment, maintenance of journals, compilation of data, establishment of controls, determination of sample size, and presentations of the results. In UT's *Knowing and Teaching Science: Just Do It* course, preservice secondary science teachers must have exhibited knowledge in performing an inquiry-based research project and in teaching via inquiry methods (Melear et al., 2000). In Bowling Green State's *Introduction to Physics Middle Childhood Educators*, preservice elementary science students were required to think about the question, interact with the materials with an inquiring mind, and then design and implement lesson plans (Van Hook, 2002).

Theory to Practice Constraints

Beginning teachers often struggle to implement university theories into classroom practices. Qualitative research of beginning teachers in implementing inquiry into their classrooms has revealed various teacher constraints and barriers (McGlamery & Fluckiger, 2001; Mellado, 1998; Yerrick, Parek, & Nugent, 1997; Appleton & Asoko, 1996; Tobin & McRobbie, 1996; Powell, 1994). The reported barriers preventing teachers from utilizing inquiry methods included transmission strategies, classroom control strategies, science content knowledge, and school culture influences.

Tobin and McRobbie (1996) discussed four cultural myths that constrain inquiry-based teaching methodologies: the transmission myth, efficiency myth, rigor myth and examination myth. The transmission myth was when the teacher views himself or herself as the principal source of knowledge. The efficiency myth was present when the teacher feels that he or she must control the classroom environment, cover vast amounts of content, and control the time factor. The rigor myth existed when the teacher feels the responsibility to maintain a high standard of learning and to make sure that learning of certain objectives occurs for the next phase. The examination myth was evident when teachers emphasize the learning of facts and algorithms to learn correct answers; in essence, students were being prepared for success on exams.

Mellado (1998) found similar barriers when observing four teachers; one teacher definitively embraced and displayed the "transmission strategy." Transmission strategies were employed when students acquired scientific content passively from the teacher. For example, in Mellado's teacher example, "the students were regarded as mere passive receptors of external knowledge" (p. 207). Mellado also reported that some teachers' actions and beliefs were in total contradiction. Yerrick et al. (1997) also discovered evidence supporting the transmission of knowledge when interviewing teachers because the teachers chose verbal responses such as "give, assign, talk about, and display" (p.145). Secondary science teachers suffered from transmission strategies primarily due to their vast subject area content knowledge. They felt they were responsible for *covering* vast amounts of content. However, for elementary science teachers, Appleton and Asoko (1996) discovered that a major barrier was actually the "lack of substantive science knowledge" (p.176).

Powell (1994) found a constraint within the mentoring program at the school site in that preservice teachers did not feel that they were allowed to "test personal theories of teaching within the daily realities of school classrooms" (p.288). Additionally, McGlamery and Fluckiger (2001) revealed school culture factors that influenced teacher's development of science pedagogical skills. Novice teachers exhibited a teaching style usually in agreement with the style supported by the school culture. Only teachers with prior careers or prior teaching experience taught with methodologies outside the school culture. An increased year of teaching experience was a positive factor in developing a constructivist teaching style. McGlamery and Fluckiger underscored the need for mentoring schools to support and provide a strong network in fostering teacher growth and professional efficacy.

Research on Teacher Preparation Programs

In 1993, "science teacher preparation [was] recognized as the pivotal point in the reform science education . . . no longer [could] science teacher preparation [be] discrete and separate from science teacher enhancement " (Brunkhorst, Brunkhorst, Yager, Apple & Andrews, 1993, p. 51). Adams and Tillotson (1995) stated that the current "research base [was] not sufficient to answer questions about what [was] needed to prepare effective teachers" (p. 442). Hence, the Salish I Research Collaborative was created to address emerging issues of teacher education.

Salish I and Salish II Consortiums

The Salish I Research Collaborative was one of the first nation-wide research efforts to measure effectiveness of preservice science teacher education. Forty-six institutions in twenty-four states collaborated producing instruments to report results of science teacher preparation and development. The first Salish Project, *Linking Teacher Preparation Outcomes and Teacher Performance,* included ten science/mathematics teacher preparation institutions (Brunkhorst et al., 1993). The Purdue Salish Project was a continuation of the first Salish project and produced the final report titled *Science and Mathematics Teacher Education Programs: Influences on New Teachers and Their Students* (Salish I Research Collaborative, 1997).

The two research questions guiding the Salish I Research Collaborative study were 1) "to uncover and understand knowledge about the relationships between secondary science and mathematics teacher preparation; new teacher knowledge, beliefs and performance; and student outcomes; and 2) to learn how to study the relationships between teacher preparation and outcomes" (Salish I Research Collaborative, 1997, p. 1). Five guiding tenets for the research were utilized. The fifth tenet included the "exploration of the linkages among the foregoing – program features, teacher knowledge and beliefs, teachers' performance, and student outcomes" (Salish I Research Collaborative, p. 1).

One contribution and outcome of the Salish I Research Collaborative study was the development of new instruments that were piloted during the five-year study. The

Salish I Research Collaborative (1997) study reported "these instruments [as contributions] to the science and mathematics education community's ability to study the effectiveness of teacher preparation programs" (p.77). As a result of the Salish I Research Collaborative, a validated science *Secondary Teaching Analysis Matrix, STAM* (Gallagher & Parker, 1995) instrument was constructed and utilized. The observational instrument classified teachers' and students' actions in relation to content, teachers' actions, students' actions, resources, and environment. The teaching style classifications were scored along a continuum from didactic, to transitional, to conceptual, to early constructivist, to experienced constructivist, to constructivist inquiry. The *Teacher Pedagogical Philosophy Interview*, *TPPI* (Richardson & Simmons, 1994) was an instrument used in the Salish project that focused on epistemology, nature of science, nature of teaching, nature of learning, and self as teacher. A third instrument, *the Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs, SIDESTEP* (McGlamery, 1993), provided background demographic information about the participants. The *SIDESTEP*, *TPPI,* and *STAM* instruments were combined to ascertain the impact of preservice teacher preparation.

The Salish II consortium, or Chautauqua for Improving Science Teacher Education Programs (ISTEP), consisted of a collaborative team of sixty-three professionals from thirteen institutions (Robinson & Yager, 1998). These professionals included scientists, science educators, educators, educational and/or science department heads, and educational and/or natural science deans. In June 1997, Salish II participants met for a weeklong workshop to discuss Salish I findings, foster collaborations, and detail fall semester pilot proposals. At the January 1998 Association for the Education of Teachers of Science meeting, ten collaborators of the Salish II project presented results of their implemented fall pilot programs.

The Salish II collaborative (Robinson & Yager, 1998) produced the report, *Translating and Using Research for Improving Teacher education in Science and Mathematics,* which detailed thirteen research studies within five themes: 1) Methods of Science: Formative Experiences; 2) Collaboration to Improve Science Teacher Education; 3) Induction of New and Student Teachers; 4) Undergraduate Science Experience that Impact Preservice Teachers: Changing Models of Teaching and Learning; and 5) Dissemination of Reformed Practices and Curricula.

Under the first theme, Methods of Science: Formative Experiences, Leslie G. Hickok, Claudia T. Melear, J.D. Goodlaxson, and Thomas R. Warne represented the University of Tennessee by providing results and implications from their first effort of the *Teaching Science: Just Do It* course implementation (Robinson & Yager, 1998). They reported that although, "student response to inquiry was slow, all students adapted and were able to design and initiate extended open-ended experiments, interpret experimental data and formulate results, and to present their work in a simulated scientific forum" (Robinson & Yager, p. 9).

This final report posed ten additional questions in areas that warranted further examination (Robinson & Yager, 1998). Two of these questions included: 1) what "kinds of program experiences that are critical or essential for providing the 'best' preparation for new teachers," and 2) what "roles that variables such as prior career and scientific research experience play in the development of effective new teachers" (Robinson & Yager, p.170).

Continued Research Utilizing Salish Instruments

Various studies using the Salish I and II instruments have been conducted to assess beginning science teachers' methods and applications of inquiry and also to link these findings to particular teacher preparation methods (McGlamery & Fluckiger, 2001; Waggett, 2001; Simmons et al., 1999; Adams & Krockover, 1999; Adams & Krockover, 1997). Adams and Tillotson (1995) believed that by combing data collection and analysis research efforts "insights into effective practices of preparing science and mathematics teachers for their careers" would be provided (p. 442).

Simmons et al. (1999) published the Salish I research results, which included ten beginning teachers who were graduates of the nine participating universities. Beginning teacher participants completed the interview *TPPI* and observational *STAM* instruments. Simmons et al. studied the perceptions, beliefs, and classroom performances of these teachers as related to their philosophies of teaching and pedagogical skills. One key finding the researchers reported was that "beginning teachers may believe strongly in a more student-centered approach to science teaching, even though they do not translate these beliefs into classroom practice (the gap between belief and action)" (p. 946).

McGlamery and Fluckiger (2001) used both the *TPPI* and *STAM* instruments to determine 1) what teachers' classroom practice looked like, and 2) what influence, if any, the teacher preparation programs had on beginning teachers' practices and beliefs. They reported a "stark contrast between [teacher] espoused beliefs (*TPPI*) and actions (*STAM*)" (p. 11). McGlamery and Fluckiger attributed the conflict between beliefs and actions to teacher enculturation within the school setting and possibly to experience-based growth from novice to expert. They reported that teacher beliefs always changed before practice changed. They stated the need for on-going teacher support within the school environment and the need for increased teacher preparation in making the leap from theory to practice.

Adams and Krockover (1999) utilized the *STAM* observational instrument as an extension of the Salish study to link preservice program experiences to teaching style. Adams and Krockover purposefully chose one teacher to participate over a three-year time span. This particular teacher had moved upward on the *STAM* teaching style continuum from didactic to conceptual teacher within his first two years of teaching. This teacher credited the *STAM* observational instrument "for providing him a picture of how he wanted to see himself as teacher" (Adams and Krockover, p.962). The researchers surmised that the *STAM* instrument stimulated the teacher to recall his preservice program experiences. They stressed the importance of a longitudinal study in capturing the effects of science teacher education programs, which may be two or three years after the program experience.

Adams and Krockover (1997) also continued a study of the Purdue University Salish participants by applying a naturalistic inquiry approach to analyze primary data which consisted of a four-question interview and observational notes. They also used the available Salish *TPPI* and *SIDESTEP* data as secondary sources to triangulate with the primary sources. One of the driving researchable questions was to determine teachers' perceptions of and concerns about their preservice program effectiveness. Five of the eleven participants commented on their pedagogical coursework; the replies ranged from total rejection of the courses to praise for beneficial aspects of the courses. Educational psychology and foundational courses were cited as the least relevant. Seven participants cited the need for an increased field experience; while, three participants felt undergraduate teaching experience as a teaching assistant prepared them to become a teacher (Adams & Krockover).

Waggett (2001) responded to the Salish study by focusing on patterns in secondary science preservice teacher beliefs and then comparing these beliefs to classroom practice. Waggett's explanatory study employed fifteen of the fifty *TPPI* instrument questions, the *Expert Science Teaching Educational Evaluation Model, ESTEEM* (Burry-Stock & Oxford, 1993) observational instrument, and the Salish *Constructivist Learning Environment Survey, CLES* (Taylor, Fraser & White, 1994). The *CLES* measured teachers' perceptions of their use of constructivist strategies in the classroom. Waggett's participants were at varying stages in the teacher preparation coursework at Iowa State University and were enrolled in one of three sequential methods' courses. Waggett expected "to find patterns of congruency between beliefs and practices as students gained more experience and knowledge" from each methods course (p.4).

Among twenty-seven participants who completed the *TPPI* and *ESTEEM*, Waggett (2001) found no significant correlations at the 0.05 alpha level between the purported beliefs and manifested action. The non-statistical interpretation of the data revealed that beliefs do not necessarily manifest themselves as desired practice. First and second semester participants rarely had coinciding beliefs and practices; however, third semester participants had increased coinciding beliefs and practices. Preservice teachers advocating student-centered approaches may teach didactically; while, experienced teachers believing in traditional tactics may exhibit student-centered practices. Waggett's study reported both situations. Her results agreed with Salish study results in that "it is difficult to predict if a teacher will exhibit teacher-centered or student-centered actions in the classroom based on self-reported instruments" (p. 46).

Even though the previous research efforts have been conducted, additional research regarding theory to practice is being solicited. Keys and Bryan (2001) stated that we "have little evidence about how practicing teachers are using conceptual change models in their own classrooms …. [and] there is a need for research on inquiry-based learning to support conceptual understanding at the secondary level" (p. 640). Keys and Bryan predicted that "studies of teacher knowledge, including pedagogical content knowledge, nature of science knowledge, curriculum knowledge and student knowledge, will be essential for developing preservice and inservice education for inquiry" (pp. 637-638). Adams and Krockover (1999) concurred with

> the importance of longitudinal research for investigating the effect of science teacher education programs. The impact of the program may not be evident until 2 or 3 years after the experience…. Furthermore … that universities and colleges should not relinquish responsibility for the

> professional development of teachers once they graduate from the programs. (p. 969)

Summary

Linking "Theory to Practice" is an obvious goal for teacher preparation institutions. Teacher preparation institutions presume they are graduating informed and capable beginning teachers based upon their course evaluations and field experiences. However, research has shown that the transference of theory to practice is not that simplistic or straightforward. Research efforts reported that teachers have numerous barriers and constraints hindering the implementation of current educational inquiry-based reform theory into classroom practice. Large collaborative studies have been conducted to provide insight into the various outcomes of teacher preparation programs; however, those studies have shown that additional research is needed. In order to prepare superior science teachers, researchers strongly advocated the continued studies of teacher preparation program outcomes.

Chapter Summary

The previously conducted research describes various methods that science teacher educators have taken to provide skills, training, and knowledge to preservice and inservice teachers in order to increase their comfort and capabilities in using authentic inquiry-based pedagogical tactics (Brown & Melear, 2002; Gilmer et al., 2002; Granger, 2002; Van Hook, 2002; Wilson & Lucy, 2002; Westerland et al., 2001; Schwartz et al., 2000; Melear et al., 2000; Hemler, 1997; Pyle et al., 1997; Spiegel et al., 1995 Gottfried, 1993). Science teacher educators discover that their students attained preservice course objectives; however, these same students did not, or could not, put those learned processes into practice in their own classrooms (McGlamery & Fluckiger, 2001; Waggett, 2001; Simmons et al., 1999). Crawford (2000) notes "The gap between research and practice may contribute to the disparity between the intended curriculum of the reforms and the implemented curriculum of classrooms"(p. 917). In essence, the science teachers are not making the leap from theory to practice, and science educators are asking why.

Existing studies provide results of a few teacher preparation programs; however, the studies continue to appeal for longitudinal studies to determine reasons for the lack of transference from theory to practice (McGlamery & Fluckiger, 2001; Waggett, 2001; Simmons et al., 1999; Adams & Krockover, 1999; Adams & Krockover, 1997). McGlamery and Fluckiger note that "tension between content acquisition and field experience has not been resolved in every case and needs further examination" (p. 12). Simmons et al. revealed many unanswered questions in areas dealing with 1) factors that influence beginning teachers' beliefs as they enter the classroom; 2) measures that assess the domains of teacher preparation; and 3) congruence of teacher's beliefs with classroom action.

As reported by Keys and Bryan (2001) more studies are needed to provide evidence about the method in which practicing teachers are using conceptual change models in their classrooms. This study will report the outcome of the science teacher preparation on participants completing the preservice secondary science teaching preparation program at the University of Tennessee. This study will classify science teachers' actions and beliefs along a continuum. Linkages between teaching style, teaching philosophy, years of experience, and preparation coursework will be explored and noted.

CHAPTER III

METHODOLOGY

This chapter addresses the rationale and utilization of an interpretive style in analyzing a mixed methodology study. The reader is referred to Appendices for instruments and corresponding standard operating procedures (SOP). Information concerning study rationale, methodology definition, participant selection, course description, researchable questions, data collection, data validation, and data interpretation are addressed under the following headings:

(1) Rationale and Mixed Methodology

(2) Research Context and Participants

(3) Questions and Method

(4) Data Analysis

(5) Summary

Rationale and Mixed Methodology

This study's rationale is embedded within the perspective that the "current national priority for systemic approaches to the reform of science and mathematics education [is] … unprecedented interest in research on the efficacy of science and mathematics teacher preparation programs in the United States" (Simmons et al., 1999, p.

931). To facilitate in-depth studies of teacher preparation efficacy across the United States, a common guide for comparing results is desirable. Historically, researchers conducted and utilized assessment methodologies of one particular institution/university; however, these assessment results were not compared to other institution's assessment measures (Anderson & Mitchener, 1994). One of the outcomes of the Salish I Research Collaborative were validated instruments for institutions to use in assessing the "relationships between secondary science and mathematics teacher preparation programs and [assessing] the knowledge, beliefs, and performances of beginning teachers" (Simmons et al., p. 931).

The desire to categorize science teachers' philosophy and practice, and then relate this information to teacher preparation is one of the driving tenets of this study. This study utilizes the Salish I Research Collaborative interview and observational instruments to gather data in lieu of self-reported questionnaires (Salish I Research Collaborative, 1997). From the selected interview and observational instruments, the researcher expects to ground the data within the context of the teacher's current theory and practice (Strauss & Corbin, 1998).

The interpretive style of this study encompasses the "paradox of how to develop an objective interpretive science of subjective human experience" (Denzin & Lincoln, 1994, p. 119). By using the collaborative Salish I Research Collaborative instruments, the researcher aims to increase objectivity of the study. However, the researcher and assistant sustain inferences in the interpretation of these instruments. The interpretive style of this study supports the *middle ground* methodology in that the "method cannot eliminate researcher subjectivity but that [it] can certainly minimize it; the [method] thereby is the criteria against which to judge that some results are more objective than others" (Smith, 1989, p. 157).

This study is exploratory, rather than confirmatory, because the purpose is stated in terms of research questions instead of hypotheses (Tashakkori & Teddlie, 1998, p. 53). The collected information consists of qualitative interview and qualitative observational data. The observational and interview qualitative data are quantitized, where "qualitative information is [converted] into numerical codes that can be statistically analyzed" (Tashakkori & Teddlie, pp. 125-126). Furthermore, the analysis of the observational data is simple valence analysis, where two raters evaluate utilizing a coding scheme and determine inter-rater reliability (Tashakkori & Teddlie, pp. 119-120). To categorize this *middle ground* method, this study is classified as "Mixed Methodology IV where the investigation is exploratory, the data and operations qualitative, and the analysis statistical" (Tashakkori & Teddlie, p. 146).

After reviewing fifty-seven studies, Greene (as cited in Tashakkori & Teddlie, 1998) distinguished five purposes of mixed method studies. This study underscores the "complementarity model, where examining overlapping and different facets of a phenomenon occur" (Tashakkori & Teddlie, p. 43). To apply the complementarity model to this study, the two facets, consisting of the teacher's philosophy and action, are examined to investigate the resulting inquiry-based phenomena based upon university teacher preparation.

Research Context and Participants

The purpose of the study was to gather data on select inservice science teachers regarding teaching philosophy and action as related to inquiry-based teaching style. The study then linked any teacher actions and/or philosophies to experiences during science preservice teacher preparation program at the University of Tennessee (UT). The science preservice preparation course, Botany 531 *Knowing and Teaching Science: Just Do It*, offered experiential inquiry-based learning to preservice teachers. Other UT inquiry-based supportive courses, detailed in Table 3, included a science teaching methods course, a natural environmental study course, and a professional development course.

Table 3

University of Tennessee Coursework Reinforcing Experiential Science Learning

Graduate Course Number	Course Description	Course Title
Sc Ed 496	Methods, materials, recent trends in science and environmental education programs for secondary schools	Teaching Science Grades 7-12
Sc Ed 506	Outdoor Education to Meet the National Science Education Standards	Science Education Studies in Natural Environments (taught on Ossabaw Island)
Ed 574/591	Describe, develop and implement strategies for inquiry-oriented teaching, resulting in an action research project	Analysis of Teaching for Professional Development and Clinical Studies

Sites

The sites for the study included the UT campus and Tennessee urban and rural, public and private, middle and high schools. The sites were selected due to proximity to the facilities, programs, and participants. All sites were within a 50-mile radius of UT campus.

Source of Participants

The eight participants for this study were selected based upon the completion of the UT *Knowing and Teaching Science: Just Do It!* course and their number of years of science teaching experience. All participants had completed or were currently in the process of completing a 36-week internship requirement for the Masters of Science degree in Education from UT. Participants were selected from three separate cohorts as defined in Table 4. Cohort 3 was not represented due to the following reasons: 1) participants left the teaching profession 2) participants taught in an environmental institute, or 3) participants were enrolled in a science research apprenticeship course in lieu of *Knowing and Teaching Science: Just Do It*. The participant numbers in the study were lower than the total graduating numbers in the cohorts due to teacher unavailability because of teachers leaving the teaching profession and/or relocating to another state.

The researcher knew all, but two, of the participants through interaction from courses at the university and from experience as an intern evaluator for four years. Six

Table 4

Cohort Description for the *Knowing and Teaching Science: Just Do It* Course

Cohort Number	Teaching Experience Year(s)[b]	Total Number Graduates	Participant Number	*Knowing and Teaching Science: Just Do It* Course Year	Internship Year
I	3	8	2	1997	1998/1999
II	2	8	3	1998	1999/2000
IV	0	11	3	2000/2001[a]	2001/2002

Note. Numerical values are explained. [a]Course was taught both Fall and Spring semesters. [b]Internship year counts as one year teaching experience within the state of Tennessee and within this study.

participants taught various courses at the high school level, while two taught life science at the middle school level. Seven participants taught in public institutions, while one taught in the private school sector. The Knox County Tennessee School System research coordinator, eight participants, and seven building-level principals agreed to participate in the research study by signing a letter of consent (See Appendix A for sample letters of consent).

Preservice Course Description

A UT College of Liberal Arts botanical geneticist, Leslie G. Hickok, and a UT College of Education science teacher educator, Claudia T. Melear, began a preservice course to provide inquiry-based experiential opportunities for preservice science teachers in 1997. The intent of the course was "to provide the opportunity to freely conduct hands-on investigative-based research with a living organism [and then] the opportunity to translate the experience into the development of laboratory applications suitable for use in a 7-12 or undergraduate classroom" (Hickok, 2002, p. 1). During the course, the students were responsible for researching an unknown individually or collectively, and for presenting an inquiry-based lesson suitable for grade 7-12 students. Additional activities to teach the research process included presenting a critical overview of a scientific research journal article and frequent presentations of research results for class discussion and formative evaluation.

All sessions of the *Knowing and Teaching Science: Just Do It* course were held in a laboratory setting. The course syllabus outlined a specific biweekly date and three-hour time period for course attendance; however, science experiments do not follow course syllabus outline dates and times. Hickok realized that it was necessary for students to have entrance to the lab on a *needed basis*; therefore, Hickok (2002) issued all students a key the second class meeting for free access to the lab. If a student had been at the lab on the weekend or another day of the week to record data and adjust experiments, then he or she did not need to remain in class the entire time on the course scheduled day. The course presented students greater autonomy than most college science courses by entrusting them with a key to the lab and by not monitoring their class-time hours.

On the first day of class, Hickok (2002) provided vials of an unknown substance to all students and situated the unknown within the current context of the time period. For example, during the first year, Hickok (Melear et al., 1999) presented the scenario that the substance was Sojourner Dust, which had been retrieved by NASA in conjunction with a mission to Mars, and that it might contain a new life form. Students were to investigate the material to discover the biology of the unknown by constructing questions, designing experiments, and interpreting data.

During class sessions, students recorded all daily activities in a laboratory-*inscription* notebook. The notebook inscriptions, defined as "signs that are materially embodied in some medium, such as paper or computer monitors" (Roth & McGinn, p. 37), included drawings, graphs, tables, lists, photographs, numerical data, questions, calculations, experimental methods, calculations, text, figures, equations, and charts. These laboratory notebook inscriptions contrasted mental representations because they were public, available, primary social objects. Students also maintained a separate notebook and wrote reflections addressing the following questions within any order and frequency: 1) How do you feel about the course, so far? 2) What frustrations, if any, are you experiencing? 3) How are groups forming, if any? 4) How much do you understand about what you are supposed to be doing? 5) Is this course similar/dissimilar to previous science courses/experiences? 6) What is the nature of scientific thinking, and specifically yours? 7) How is your own scientific thinking developing? 8) What is scientific thinking? 9) What is the nature of science? To encourage candid reflections, Melear collected the reflections and students were informed that the principal instructor, Hickok, (2002) did not read the student reflections until after course completion.

Course grading included rubrics for the oral and written presentations. The laboratory notebook was evaluated with a rubric beginning in 2001; the rubric had a scale from absent, to poor, to fair, to adequate, to good, to excellent. The notebooks were assessed for the following criteria: Neatness and Clarity; Transformation of Data (combining simpler and less abstract inscriptions into more complex ones); Social Use of Inscriptions; and General Improvement Over Time (Lunsford & Melear, 2002; Lunsford, 2002).

Three additional UT courses, listed in Table 3, underscored and reinforced the experiential learning from the *Knowing and Teaching Science: Just Do It* course. These courses afforded the preservice teacher the opportunity to continue in doing inquiry experiments and then in writing inquiry-based lesson plans for future science teaching. The *Teaching Science Grade 7-12* course offered opportunities to perform inquiry-based experiments with objects such as fish, seeds, earthworms, and rolly pollies. The *Ocean Beach and Estuarine Ecology Education and Ornithology and Beach Processes* course included three informational classes on UT campus for preparation in camping four days on uninhabited Ossabaw Island, located off the coast of Savannah, Georgia. Students performed math and science inquiry-based experiments utilizing living and nonliving items on the island. Some experimental topics from prior years have included inquiry research on island erosion, fiddler crab habitat, horseshoe crab body length, dog fennel density, resurrection fern density, etc. The reader is referred to the course website for additional information http://web.utk.edu/~ctmelear/ossabaw/. The *Analysis of Teaching and Professional Development/Clinical Studies* course required students to write lesson plans including inquiry-based learning techniques for students as well as complete an action research project.

Questions and Method

All three instruments and corresponding standard operating procedures utilized in this study were from the Salish I instrument packet and user's guide (Salish I Research Project Supplement, 1997). Permission to use each instrument was obtained from each instrument author(s) via email correspondence. Methodology is explained according to the research questions addressed.

Demographic Information

Each participant completed the *Salish I Research Project's Inventory for Demographic Evaluation of Schools and Teacher Education Program (SIDESTEP)* (McGlamery, 1993) detailing individual demographic information. The researcher gathered this demographic form concurrently with the observational data form. Refer to Table 7 in Chapter IV for demographic data**.** Question 3 and Question 4 of the *SIDESTEP* – Part II are modified from open-ended questions to include multiple-choice questions (see Appendix B for *SIDESTEP* Part I, II, and III & Standard Operating Procedure, SOP).

Interview Protocol

Research Question 1: What are the philosophical tenets of beginning teachers with regard to inquiry instruction?

Research Question 2: How have these same teachers' practices and beliefs been influenced by the University of Tennessee science teacher preparation program?

To address the research questions, an interview protocol was utilized. Each participant was contacted in person to participate in an audiotaped interview. Based upon relevancy to the study, fourteen of forty-four questions were selected from the *Salish I Research Project's Teachers' Pedagogical Philosophy Interview* (*TPPI*) (Richardson & Simmons, 1994) instrument. Two meetings with Dr. Russell French, a UT Assessment & Evaluation Professor, were conducted to select the most germane questions to this particular study. All interviews were conducted following the Standard Operating Procedure (SOP) of the *TPPI* instrument.

All audiotaped interviews were conducted at the participant's school site during the teachers' planning period, lunch period, before school, or after school. All interviews were conducted in a three-month time period from November 2001 through January 2002. The principal researcher transcribed the audiotaped interviews, and according to the *TPPI* SOP [Instrument Package & User's Guide (IPUG), 1997, p. 50], the researcher analyzed the selected questions using the *Coding Scheme for the TPPI* (see Appendix C for selected *TPPI* interview questions, *TPPI* Instrument questions, SOP, & coding scheme).

Observation Protocol

Research Question 3: What are the teachers' observable practices in the classroom? How do these actions align with inquiry instruction?

Research Question 4: Are teacher's actions consistent with their philosophy? Are there measurable differences in the presence and quality of inquiry instruction among the three cohorts within the classroom?

To address the research questions, an observational protocol was utilized. The observational *Salish I Research Project's Secondary Science Teacher Analysis Matrix (STAM)* (Gallagher & Parker, 1995) was selected for this study. To follow the *STAM* SOP, three hours of videotaped instruction were collected (see Appendix D for *STAM* instrument, SOP, Unit Content Journal, & Daily Journal). Each participant selected two to three calendar dates for a combined total of three continuous hours of videotaped classroom observation. To observe and collect three hours of instruction from each participant, six participants were observed and videotaped for two days; while, two participants were videotaped for three days. Six participants taught on a block schedule where they instructed 90-minute classes; these participants were videotaped for two consecutive days. Two participants instructed 55-minute classes during the day and were videotaped for three consecutive days. All video observations were completed within a three-month (January – March) time frame as listed in Table 5.

Varying levels of Biology listed in Table 5 included Biology, Basic Biology, and Honors Biology. These three levels of Biology, along with two other levels, were

Table 5

Participant's Observational Date, Time, Grade, Subject Area, and Years Teaching Experience

T#	Teacher[a]	Grade Level	Subject Area	Observation Dates 2002	Class Time (3 hours)	Years Teaching Exper-ience
T1	Richard	9	Physical Science	February 28 and March 1	8:30-10:00 am	0
T2	Susan	10	Biology	January 29, 30*	2:00-3:30 pm	0
T3	Tanya	9	Honors Biology	March 13*, 14	8:30-10:00 am	0
T4	Nancy	10	Basic Biology	February 11, 12	8:30-10:00 am	2
T5	Nathan	8	Life Science	January 24*, 25*, 28*	11:05-12:00 pm	2
T6	Delaine	9	Honors Biology	March 13*, 14	12:20-1:50 pm	2
T7	Lucy	9	Physical Science	March 7, 8*	8:30-10:00 am	3
T8	Eileen	7	Life Science	March 21*, 25*, 26	9:55-10:45 am 10:21-11:11 am	3

Note. [a]Pseudonyms are used to preserve anonymity. *Signifies dates assistant viewed videotapes.

differentiated in the Knox County curriculum guidelines (Bearden High School, 2002) and are defined as such:

> *Basic Biology I* – This Biology course is designed to provide the science unit needed to meet the minimal requirements for graduation. It is intended for students with a variety of learning styles and special needs
>
> who require an adaptive program to develop an understanding of the growth and development of living things. Course topics are selected to relate real life processes to everyday experiences and utilize basic laboratory activities.
>
> *Biology I* – This course is designed to meet one of the science course requirements as well as graduation requirements for college-bound students. Ninth grade students who select Biology I should have strong reading, math (algebra) and study skills. The goal of Standard Biology I is to develop an understanding of the diversity and unity in living things.
>
> *Honors Biology I* – This course is designed to meet the needs and graduation requirements of the more academically able student. Student selection is based upon a combination of standardized scores, past performance in science, teacher recommendations and established enrollment limits. Students must be in the top 5% in reading comprehension and have outstanding Math and Science grades to be considered. Honors biology places an increased emphasis on the development of critical thinking skills.
>
> *Biology II* – This course is designed for those students interested in expanding their understanding of concepts presented in Biology I. Recommended for students with a grade of B or above in Biology I.
>
> *AP Biology* – A Biology II course which follows the syllabus of the College Entrance Examination Board's Advanced Placement Program. The AP Biology curriculum is designed to prepare students to take the College Board AP Biology test given in May of each year. Students may be required to attend additional classroom or laboratory session beyond the usual fiver periods per week.
> (p. 45)

Data Analysis

Stages of Analysis Overview

Each *TPPI* interview was transcribed and coded using Level 1 and Level 2 analysis of *TPPI* SOP. A three-paragraph summary from participants' supportive statements was provided for each participant. The *TPPI* summary consisted of a three paragraphs representing teachers' actions, students' actions, and teacher philosophy.

The researcher and assistant coded each *STAM* observation independently. The assistant's *STAM* data was used for inter-rater reliability purposes only. Each participant's *STAM* Record of Activity Sheet (see Appendix E for each Participant's *STAM* Record) was used in writing a six-paragraph summary, the Video Portfolio Summary. The *Video Portfolio Summary* consisted of one overview paragraph and five paragraphs representing the categories of content, teacher's actions, student's actions, resources, and environment. The researcher compiled and statistically compared *STAM* results of the two separate data sets to determine inter-rater reliability. An acceptable inter-rater reliability was selected at 80%, as this was the inter-rater reliability reported by the 1997 Salish I Collaborative. The *STAM* and *TPPI* codes were compared for linkages between preservice teacher philosophy and practice (see Figure 1 for a flowchart of the *TPPI* interview and *STAM* observational analysis).

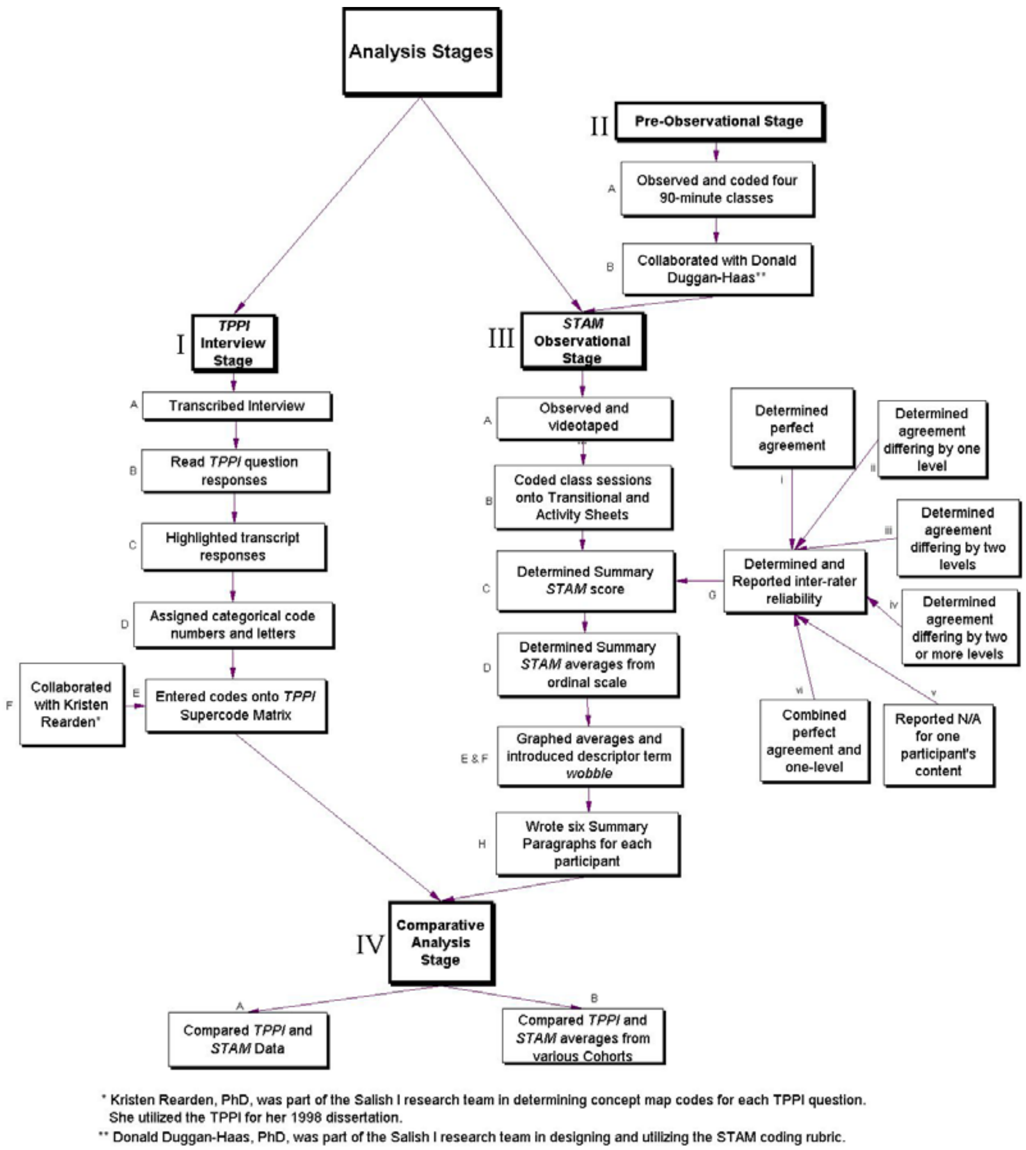

Figure 1. Flowchart of *TPPI* Interviews, *STAM* Observational, and Comparative Analysis Stage Sequence.

I. TPPI Interview Stages of Analysis

A) Each interview was transcribed.

B) The first question of all eight *TPPI* transcripts was read before reading the following questions.

C) Each question response that aligned with a concept map category was highlighted on the transcript. The analysis method followed the *Coding Scheme For TPPI for Level 1 Analysis* (see Appendix C for Level 1 SOP).

D) Categorical code numbers and letters were assigned by utilizing each question's concept map. Code letters and numbers were written on the highlighted portions of each participant's transcript.

E) Each participant's first level analysis was entered onto the provided *TPPI Super code* matrix of columns and rows to complete Level 2 Analysis (see Appendix C for Level 2 SOP).

F) Validity and reliability information were not provided with the *TPPI* instrument. Collaboration with Dr. Kristen Rearden (personal communication, February 25, 2002) occurred in order to confirm correctness of Level 1 and Level 2 coding. Dr. Kristen Rearden, an Assistant Elementary Science Education Professor at the University of Tennessee, was part of the Salish I research collaborative in designing concept map codes for each *TPPI* question. She had used the *TTPI* instrument in her 1998 dissertation conferred from Texas A&M University.

II. STAM Pre-Observational Stages of Analysis.

A) During *STAM* training, the researcher and assistant observed four 90-minute class sessions of secondary science teachers who were not participants of the study. The researcher and assistant independently scored each teacher's style and then met to discuss and quantify rubric statements such as *few, some, and many* (IPUG, 1997, p. 132-1). These changes and understandings were made with the rubric during training to increase inter-rater reliability. Correspondence with Dr. Donald Duggan-Haas, Assistant Science Education Professor at Cornell, on the correctness of *STAM* training and usage of the *STAM* rubric was conducted via email (Duggan-Haas, personal correspondence, November 4, 2001 & February 15, 2002). Dr. Donald Duggan-Haas had assisted with the authoring of the *STAM* instrument. Additionally, Duggan-Haas, Gallagher, and Parker (2001) were in process of writing a comparison/contrast research article between the *STAM* (Gallagher & Parker, 1995) and *ESTEEM* (Burry-Stock, 1993) observational instruments.

III. STAM Stages of Analysis of Observational Data

A) Eighteen separate class sessions were observed during a three-month time span (January – March). Each participant had a total of three hours of taped instruction, and each of the participants' units of instruction included two to three consecutive days. The videotaping was conducted according to the *Video/Portfolio/Classroom Observation SOP* (see Appendix D for *STAM*

Classroom Observation SOP). The assistant either attended the entire class session or watched the video of the class session (see Table 5). The assistant then independently coded and reported the participant's *STAM* teaching style to the researcher. The assistant was selected for the study because of her experience as a prior middle school teacher and previous familiarity with the *STAM* instrument. Additionally, the assistant was a doctoral student in the science education department at UT and was currently enrolled in the UT *Knowing and Teaching Science: Just Do It* Course.

B) Each segment of the participant's lesson was defined as transitional- or activity-based instruction. *Transitional* phases were defined as those portions of class time devoted to beginning or ending an activity. *Activity* phases were defined as those portions of class time where content instruction was observed. All activities and transitions were reported on an Activity/Transition Timeline Sheet (see Appendix E for each participants *STAM* Record). The transitions and activities were then coded using the *STAM* Analysis Matrix.

C) The summary *STAM* score for each participant's twenty-two subcategories was compiled in tabular format (see Chapter IV Tables 19-26). The *STAM* instrument signifies each style with a letter: didactic was A; transitional was B; conceptual was C; early constructivist was D; experienced constructivist was E; and constructivist inquiry was F.

D) A *STAM* numerical Average was determined for five categories: content, teachers' actions, students' actions, resource, and environment.

a. To calculate the simple numerical average, an ordinal number ranging between one and six was assigned to each of the following styles: didactic (A) was 1; transitional (B) was 2; conceptual (C) was 3; early constructivist (D) was 4; experienced constructivist (E) was 5; and constructivist inquiry (F) was 6.
b. To determine the *STAM* content average for each participant, the coded subcategorical items (1-4) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 4.
c. To determine the *STAM* teachers' actions average for each participant, the coded subcategorical items (5-11) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 7.
d. To determine the *STAM* students' actions average for each participant, the coded subcategorical items (12-16) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 5.
e. To determine the *STAM* resource average for each participant, the coded subcategorical items (17-20) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 3.
f. To determine the *STAM* environment average for each participant, the coded subcategorical items (21-22) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 3.

E) The averaged ordinal data were represented as numbers. The data descriptor term *wobble* was utilized to signify a score between the ordinal values. A number between 1 and 2 was reported as 1/2; a number between 2 and 3 was reported as 2/3, and a number between 3 and 4 was reported as 3/4. Value 1/2 signified a participant's *wobbling* between the didactic and transitional style; the value 2/3 signified the participant's *wobbling* between transitional and conceptual; while, the value 3/4 signified participant's *wobbling* between conceptual and early constructivist.

F) The *STAM* content, teachers' actions, and students' actions, resource, and environment averages of all participants were displayed on a bar graph.

G) The *STAM* scores were compared between the two raters to determine a ≥ 87 % inter-rater reliability

    a. Inter-rater reliability between raters' analyses of each participant's *STAM* was calculated in the same manner the Salish I study 80% inter-rater reliability was reported (Duggan-Haas, Gallagher, & Parker, 2001).

        i. Perfect agreement was noted when both data sets presented identical item coding. Additionally, perfect agreement was noted when item agreement within the spread of codes was found. For example, codes A and A, or A and A/B, noted perfect agreement between the items. Perfect agreement was determined by dividing number of items with perfect agreement by the total number of possible items (22).

ii. One level away from perfect agreement between items was noted as an A and B, or B and C, etc. Items differing by one level of agreement were determined by dividing that number by the total number of possible items (22).

iii. Two levels away from perfect agreement between items were noted as an A and C, or B and D, etc. Items differing by two levels of agreement were determined by dividing that number by the total number of possible items (22).

iv. Greater than two levels away from perfect agreement were noted as an A and D or B and E, etc. Items differing by greater than two levels of agreement were determined by dividing that number by the total number of possible items (22).

v. A *Not Applicable (NA)* rating was utilized for one participant in the content category, as researcher and assistant agreed the *STAM* could not measure the four content subcategories from the two observed class sessions.

vi. The percentages of agreement between the researcher and assistant *STAM* items are detailed in Table 6 for each participant. The perfect agreement item percentage was combined with the one-level from perfect agreement item percentage to determine an overall inter-rater reliability of ≥ 87%. Hence, this was the condition upon which all *STAM* data was reported and interpreted.

Table 6

Inter-rater Reliability Between Researcher and Assistant for *STAM* Matrix Items

Teacher Number	Teacher Name***	Matrix Item Perfect Agreement*	One Level from Matrix Item Perfect Agreement*	Two Levels from Matrix Item Perfect Agreement*	Overall Inter-rater Reliability
T1	Richard	77	18	5	95
T2	Susan	50	41	9	91
T3	Tanya	73	18	9	91
T4	Nancy	77	18	5	95
T5	Nathan	60	31	9	91
T6	Delaine	73	18	9	91
T7	Lucy**	56	39	5	95
T8	Eileen	23	64	13	87

Note. *Values are reported as percentage. **Lucy's values are based upon 18 instead of 22 subcategories. ***Pseudonyms replace actual teacher's names.

H) A *Video Portfolio Summary* consisted of paragraphs labeled overview, content, teacher's actions, student's actions, resources, and environment. Within the overview paragraph, values enclosed in parentheses indicated the frequency each category was selected.

IV. Comparative Analysis Stage

A) Student's actions and teacher's actions were compared between the coded *TPPI* Interview and *STAM* Observation data. Both the *TPPI* and *STAM* rubrics align on similar grids with identical descriptive columns titled didactic, transitional, conceptual, early constructivist, and experienced constructivist.

a. A simple numerical average was calculated from the *TPPI* and *STAM* data for the teacher's actions and student's actions. To calculate the simple numerical average, an ordinal number ranging between one and six was assigned to each of the following styles: didactic was 1; transitional was 2; conceptual was 3; early constructivist was 4; experienced constructivist was 5; and constructivist inquiry was 6.

i. To determine the *TPPI* teacher and student's actions average for each participant, the coded style responses were averaged. For example, if a participant had all teacher-action professed statements scoring within the didactic style, then a number (1) was assigned. However, if a participant had teacher-action professed statements coding within the didactic, transitional, and conceptual styles, then a number 1, 2, and 3 was assigned and then divided by 3.

ii. To determine the *STAM* teachers' actions average for each participant, the coded subcategorical items (5-11) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 7.

iii. To determine the *STAM* student's actions average for each participant, the coded subcategorical items (12-16) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 5.

b. The averaged ordinal data were represented as numbers. The data descriptor term *wobble* was utilized to signify a score between the ordinal values. A number between 1 and 2 was reported as 1/2; a number between 2 and 3 was reported as 2/3, and a number between 3 and 4 was reported as 3/4. Value 1/2 signified a participant's *wobbling* between the didactic and transitional style; the value 2/3 signified the participant's *wobbling* between transitional and conceptual; while, the value 3/4 signified participant's *wobbling* between conceptual and early constructivist.

c. The *TPPI* and *STAM* teacher and students' actions averaged data of all participants were displayed on a bar graph

B) An average of each cohort group's *TPPI* and *STAM* teacher and student's actions score was determined. To compute the cohort average, simply add the averaged scores from every cohort member and then dividing by the number in the cohort group. The *TPPI* and *STAM* averaged scores from Cohort 1, 2, and 4 for teachers' actions and students' actions were reported.

Summary

This chapter detailed the design of the study by connecting Mixed Methodology IV protocol to specific aspects of this study. The selection of participants, sites, and a detailed description of the *Knowing and Teaching Science: Just Do It* course were included. The research questions along with the demographic, interview, and observational protocols were provided. A detailed schema and written description of the data analysis was shown. Lastly, the steps for comparing the *TPPI and STAM* data were described. Chapter III detailed the method and procedures for collecting and analyzing the data. The results will be presented in the following chapter.

CHAPTER IV

RESULTS

Organization of the Chapter

This Chapter is organized into five sections:

1. *Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP)* data detailing race, age, gender, education, subject areas, school setting, and school enrollment

2. *Teacher Pedagogical Philosophy Interview (TPPI)* data concerning teacher actions, student actions, and philosophy of teaching

3. *Secondary Science Teacher Analysis Matrix (STAM)* observational data concerning science content, teacher actions, student actions, assessment, environment, and resources

4. Beliefs (*TPPI* data) compared to teaching performance (*STAM* data) for teacher action, student action, and years teaching experience.

5. List of findings of educational importance

Demographic Data

The *SIDESTEP* instrument produced the following information about the participant group: (1) all participants were middle-class Caucasian; (2) all participants, except Eileen, taught in the public school sector; (3) all had or will have a graduate degree in Education by Summer 2002; (4) and all had completed or were engaged in a 36-week internship at a middle or secondary school setting. Two participants were male; while, the remaining six participants were female. All six female participants had an undergraduate degree in Biology. The two male participants had degrees in Business and

Psychology. Two of the participants taught in a rural school setting; two taught in an urban setting; and the remaining four taught in a suburban school setting. Student enrollment was much lower in Eileen's K-8 private school than the other public schools. Data regarding age, gender, education, subjects taught, school enrollment, and school classification are shown in Table 7.

Interview Data

The beginning nine question from the selected fourteen *TPPI* interview questions were coded into three categories: teacher's actions (TA), student's actions (SA), and philosophy of teaching (PT). Definitions of the coding terms TA, SA, and PT were provided in Chapter I under the *Definition of Key Terms.* The beginning nine questions addressed Research Question 1; while the remaining five questions, introduced later in the chapter, addressed Research Question 2. The beginning nine questions and their corresponding coding category(s) were:

1. Describe a well-organized classroom. (TA)
2. Describe the best teaching/learning situation that you have ever experienced. (PT)
3. In what ways do you try to model the best teaching/learning situation in your classroom? (PT)
4. What are some of the impediments or constraints in implementing that kind of model? (TA)
5. What are some of the tactics you use to overcome these constraints? (TA)
6. How do your students learn best? (SA & PT)
7. How do you know when your students understand a concept? (SA & PT)
8. In what ways do you manipulate the educational environment to maximize student understanding? (TA & SA)
9. How do you accommodate students with special needs in your classroom? (SA)

Table 7

Participant Demographic Information

T#	Teacher Name**	Age	Gender	B.S. Education	Subjects Taught During Teaching Career	School Enroll-ment	School Classifica-tion
T1	Richard	32	M	Business Admin/ Marketing	CP Biology I* Basic Biology I* Phys. Science	872	Urban
T2	Susan	43	F	Biology	Biology I* Phys. Science	760	Urban
T3	Tanya	23	F	Biology	Basic Biology I* Hon. Biology I* Phys. Science	1400	Suburban
T4	Nancy	28	F	Biology Minor Chemistry	Biology I* Biology II* Phys. Science Life Science AP Biology*	1348	Rural
T5	Nathan	29	M	Psychology	Phys. Science Biology I*	1200	Suburban
T6	Delaine	24	F	Biology Minor Chemistry	AP Biology* Ecology Phys. Science Biology I* Biology II*	1400	Suburban
T7	Lucy	27	F	Biology	Phys. Science Biology I* Basic Biology* Ecology	918	Rural
T8	Eileen	28	F	Biology	Life Science	265	Suburban

Note. *Levels of Biology courses are described on pages 53-54. ** Pseudonyms replace actual teacher's names.

Further coding of the questions was completed in accordance with the *TPPI* Supercode Matrix. The six codes of didactic, transitional, conceptual, early constructivist, experienced constructivist, and inquiry constructivist were collapsed into three Supercodes. The Supercodes were as follows: 1) didactic and transitional were combined as teacher-centered Supercode didactic/transitional; 2) conceptual was retained as Supercode conceptual; and 3) early constructivist and experienced constructivist were combined as student-centered Supercode early constructivist/experienced constructivist. The experienced constructivist code was omitted from the data because no participant response coded at that level.

The teacher-centered *didactic/transitional Supercode* beliefs and actions occurred when the teacher was the chief conduit of the content knowledge; in essence, the teacher transmitted the content knowledge to the passive students. The teacher delivered factual information from textbooks, videos, and other resource with minimal student input. The *conceptual Supercode* beliefs and actions occurred when the teacher emphasized the exploratory nature of science. Teachers encouraged some student-to-student interaction and explored science content via important ideas and key concepts. The student-centered *early constructivist/experienced constructivist Supercode* beliefs and actions occurred when the teacher acted as a facilitator in guiding the students' activities. The students were responsible in acquiring and processing their own scientific knowledge, thereby gaining knowledge through their own actions (Simmons et al., 1999).

Each participant's transcript was summarized into three paragraphs, a paragraph detailing teacher's actions, student's actions, and philosophy of teaching (see Chapter I

Definition of Key Terms). The three-paragraph summary categorized teacher's actions, student's actions, and philosophy of teaching data into one or more of the Supercode categories of didactic/transitional, conceptual, and/or early constructivist (see Appendix C for *TPPI* Standard Operating Procedure). Subsequent to the each participant's summary paragraphs is a tabular representation of selected supportive interview transcript data. The summary paragraphs and interview data Tables 8-15 (*TPPI* Interview Codes and Transcript Statements for each Participant), Table 16 (Participant *TPPI* Codes Where 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist, and 6=Inquiry Constructivist), and Figure 2 (*TPPI* data representation for each participant's teachers' actions and students' actions) are provided to address Research Question 1.

Research Question 1: What are the philosophical tenets of beginning teachers with regard to inquiry instruction?

TPPI Participant Summary

Richard (T1) exhibited mostly an early constructivist style for teacher actions. Richard believed the classroom should be designed in a semicircle where you can make eye contact with those you are speaking. He believed the classroom environment depended on the students and recognized the variety of personality and learning styles within one classroom. He tried to focus on the strengths of the students in giving them the opportunity to teach each other. He believed every student's opinion mattered, and he was concerned with how every student was making connections with their own thought processes. Richard would rather spend class time having students discuss things and do an activity than spend that time giving a lecture.

Richard's student action style varied from didactic/transitional to conceptual. Richard stated that he could tell his students had learned by the expressions on their faces. He believed in assessing students by asking them directly and having them write in their journals how they learned best. Richard gave students a variety of activities that accommodated their learning styles and needs.

Richard's philosophy of teaching was conceptual in that he attempted to make every lesson relevant to the student's lives. He planned things in the class that appealed to the students and would spark their interest. Refer to Table 8 for Richard's supportive transcript quotes.

Susan (T2) exhibited actions across didactic/transitional and conceptual and early constructivist styles for teacher actions. Within a didactic mode, she cited time constraints as prohibiting her from planning as thoroughly as she would have liked. However, her transitional teacher behavior was expressed when she dressed in a costume, wrote a play/script, and decorated the classroom for the Halloween holiday. She was willing make the extra effort to make science in her classroom fun and different. She wanted the science classroom to look lived-in with stuff all around and to appear disheveled, as if the students were actually doing things.

Table 8

***TPPI* Interview Codes and Transcript Statements for Richard (T1)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic		I can tell students have learned at times "through the expression on their faces"	
Transitional		I think the best way of assessing their learning is "asking them to tell you honestly."	
Conceptual	"I have noticed that I ask a lot of questions in order to keep all the students involved."	I have had the students write in journals and asked them point blank how do you learn best. A lot of the students say they learn best with "hands-on activities or visual aids" Students with special needs can be accommodated "with lesson plans and activities . . . . by centering it more towards a lower level activity."	"I try to make every lesson relevant." Students learn with something that "appeals to them . . . and sparks their interest"
Early Constructivist	The classroom seating should be in a "semi-circle rather than rows because you would rather make eye contact with the people you are discussing things with." "The classroom environment depends on the personality of the students and the material you are teaching. So, I think it depends on the student really" making the model fit to everyone's personality or leaning type. "You got a conglomeration of just a diverse classroom, and it is not only in size but in different personalities and different cultures" "I really try and focus on the strengths of those students, and in doing so maybe they will able to teach someone else who has the weakness."	"The students learn in a variety of ways."	

Table 8 (continued)

***TPPI* Interview Codes and Transcript Statements for Richard (T1)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Early Constructivist	"I try to make every student's opinion matter, which they should in the classroom." "I would much rather have them asking questions and discussing rather than me just giving straight lecture and then doing an activity." "I want to be able to learn what they are thinking, how they are thinking and how they are making connections to different things and what their thought process is."		

The student's actions were transitional to conceptual as students were dancing to an inertia song, doing hands-on activities, and receiving specialized attention one-on-one. She believed in having the students engaged and having fun with science.

Susan's philosophy of teaching consisted of mostly early constructivist beliefs in that the students were actively engaged in making observations and asking questions that the she herself could not answer. Refer to Table 9 for Susan's supportive transcript quotes.

Tanya (T3) exhibited actions across didactic/transitional, conceptual, and early constructivist style for teacher actions. Her didactic teacher actions dealt with management issues regarding student seating and attitudes. Her transitional actions conveyed that the teacher should be well-planned and adaptable. Conceptual teacher actions placed more responsibility on the student for learning as the students should know what they are supposed to be doing. Early constructivist actions included understanding

Table 9

***TPPI* Interview Codes and Transcript Statements for Susan (T2)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	definitely "time constraints . . . to prepare as thoroughly probably as you would like" In regards to planning "I definitely needed a little more meat to it."		Put a lot of time and effort into planning a lesson so that it has some depth to it, has some variety
Transitional	"I came dressed in a costume and decorate for Halloween and made a lesson around a Halloween topic just to make it sort of fun and different."	In gauging student understanding "to work with someone one-on-one and you are helping them work through it and then you see that light bulb go off and realize that they have gotten it."	"Sometimes, it may be talking with them – it seems to be more of a one-on-one type of thing when you really realize that they got it."
	"I was willing to do some extra stuff to try and help them to lean and help it be a more fun experience, so I hope that is coming across."	"… the Mitsubishi *Body in Motion* song should be our inertia song . . . . we played the [cd] and danced."	
	The room "looks like it is lived in and students are actually participating and doing things and almost like you have stuff around."	Spend extra time with "more specialized attention" for students with special needs.	
Conceptual		Students learn by "doing hand-on and getting involved." "make the class fun and engaging "	"I feel like if they are involved and if they are doing hands-on things, I think they are learning."
Early Constructivist	When referring to the classroom environment "I would rather see it kind disheveled and looking like the students are actually doing things.		"I had few different demonstrations in which I was getting the students to make observations and describing the history and development of the scientific method . . ." "kids just started asking questions and I was so thrilled that they were asking questions and not waiting for me to give them all the information." "Greatest experience as a teacher, to feel like you know that they are so interested that they are asking you questions you cannot even answer." Working on higher order questions where they formulate answers rather than trying to arrive at right answers

that some students may exhibit bad attitudes due to their lack of previous success in science. Additionally, Tanya negotiated discussions and talking among students during class activities.

Student actions were predominately transitional and conceptual. Tanya believed the students should be doing or seeing something science related. She believed in personal attention and tailoring goals for each student. She believed students learned best actively. She expressed concern that every activity should be linked adequately with the concept to assist understanding.

Tanya's philosophy was expressed in didactic/transition and early constructivist domains. Tanya didactically felt that she was responsible for making it clear what was expected of the students. Transitionally, she believed in having respect for and encouraging each student. Tanya's early constructivist philosophical thoughts arose from a student success story in her class. The empowering effect that the success had on that particular student and other students in the class was encouraging to Tanya. Refer to Table 10 for Tanya's supportive transcript quotes.

Nancy (T4) exhibited actions across didactic/transitional to early constructivist styles for teacher actions. Nancy's classroom management techniques were didactic as she assigned fifty sentences or detention if students were not on task. Transitional teacher actions included a classroom environment of fish tanks, plants, and shelved specimens. Most of her teacher action was early constructivist style as the classroom seating design was intended for the students to face each other so the students could have interactions with each other rather than just her. Nancy tried to ask the students questions

Table 10

***TPPI* Interview Codes and Transcript Statements for Tanya (T3)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	"I just got more forceful, but now I have learned that if I get bad attitude, I just smile and try and reason with them." "don't have them in assigned seats."		"make it clear what is expected of the students"
Transitional	"teacher is well-planned, the teacher is well prepared" Teacher is able to "adapt to things that come up to keep it organized." "giving them a handout and filling blanks for notes, instead of just transcribing everything I am saying"	"actively doing something or actively seeing something" "the deaf student obviously has an interpreter" "The student with a severe writing handicap has personalized attention, allowing him to make up the work later, giving him several opportunities to do it, because it takes him so much longer."	"have respect for the kids" "be really encouraging"
Conceptual	"The students know what they are supposed to be doing."	Students learn best "actively." "have to be careful that when I do all these activities, that I tie them back or else they are just like well that was fun . . . . But usually I we come back and talk about it, they are pretty good about getting the point."	
Early Constructivist	Impediments or constraints are students "bad attitudes I guess." "They are not used to doing well and they don't see a reason to try to do well." I "allow an extensive amount of socialization because they are going to anyway, so if you direct a little more, give them opportunities like work on this while you work on this and you can talk to your friends."		"she got all into hers and used the computer and made it all beautiful and was encouraging everybody else to do it and talking about how much she was learning out of this class. She was giving pep talks to everybody. If she could bring her grade up and she has a C now, then they could do the same and they should try."

to get them more motivated to discuss things; however, classroom management remained the biggest constraint.

Nancy's student actions varied from didactic to conceptual to early constructivist. Nancy felt that her AP Biology class learned differently from her Basic Biology class, as her AP class wanted to hear her talk most of the class time and her Basic class wanted to do things. She also displayed didactic style in knowing when her students had learned a concept. She felt if her students could explain the concept back to her, she knew they had learned the concept. Nancy's students displayed conceptual actions as they wrote guided notes, performed class activities in little steps, and utilized visual aids. Nancy believed in pre-teaching vocabulary to the students to help with scientific terminology. Nancy exhibited early constructivist behavior when utilizing students' models and posters as topics of student discussion and classroom learning tools. She had students teach each other in groups, conduct hands-on investigations, and conduct presentations.

Nancy's teaching philosophy was transitional to conceptual to early constructivist. Transitional beliefs included the attempt to break up the 90-minute class into segments; she felt the Basic biology classes did not want to here her talk all the time. She monitored the room and usually visited everyone in the class to ask them a question. She repeatedly stated her beliefs in having the students do hands-on cooperative group activities where the students can discuss things and not have to listen to her all the time. She discussed the Watershed project where her students were in the creek collecting bugs and analyzing the water quality based upon the bug sampling data. Refer to Table 11 for Nancy's supportive transcript quotes.

Table 11

***TPPI* Interview Codes and Transcript Statements for Nancy (T4)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	"I give them fifty sentences to do because they weren't on task." "I try to think of alternatives or punishments in my own classroom that I can handle, such as detentions for me and then I will call their parents of course."	"with my AP class, that is a different story, they all want to hear me talk for some reason." Students have learned "when they can explain it back to me …. and also of course I do testing."	
Transitional	like to have "fish tanks, plants, specimens"		"Try to break it up into segments . . . . that kinds of breaks up the whole lecture thing because with my life science, I know they don't want to hear me talk the whole time, and they would rather be doing things." "I usually get around to everyone in my class and ask them one question on one concept that I think they have learned so probably through discussing with them what is going on."
Conceptual		"Because they all need a little help sometimes, I give guided notes where they just fill in the blanks" "I try to do things in little steps . . . and you know more visual things." I do "peer tutoring, cooperative groups." "pre-teach vocabulary [by having them] write the vocabulary word and then draw a picture of it so that way they can kind of get the meaning with the picture"	"doing hands-on or cooperative groups where they just discuss things I want them to discuss"
Early Constructivist	"I like for the desks to be kind of together where the kids can face each other, like maybe in a circle or something." "Have students have some interactions with themselves instead of just with me."	"When the students create their own posters, I always put those on the wall." "They make that poster or talk to their group about it and I think they learn pretty well from that."	"They learned more from doing that kind of stuff than just sitting in my classroom listening to me talk about it." "taking my students to the creek and they were actually in the water collecting the bugs and identifying the bugs and determining the water quality based on the bugs"

Table 11 (continued)

***TPPI* Interview Codes and Transcript Statements for Nancy (T4)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Early Constructivist	"classroom management, I think, is biggest constraint" "I try to ask them questions to get them more motivated to discuss things."	"I like to use a lot of models, just stuff that they have created." "I agree with cooperative groups, and hands-on activities and some presentations." They learn a lot "because they have to teach somebody else about their biomes and what is in them."	"getting them into groups to discuss . . . or get in their group to do a little activity."

Nathan (T5) exhibited actions across didactic/transitional styles for teacher and student actions. Nathan cited one reason for not doing a great extent of hands-on-stuff as a function of class size. Nathan also indicated that he was unable to schedule enough time for what he wanted to do as he was already at school twelve hours a day. Other impediments included supervisory demands and administrative constraints.

Student actions were didactic/transitional style. Nathan believed student fear played a large role in manipulating the classroom environment and believed that when a student forgot a book, a demerit was warranted.

Nathan's philosophy of teaching ranged from didactic/transitional to conceptual to early constructivist. He felt the class should be relaxing and enjoyable; he felt the students should be communicated with by the teacher and with others. He also believed in utilizing peer tutoring. Refer to Table 12 for Nathan's supportive transcript quotes.

Delaine (T6) exhibited actions across didactic/transitional, conceptual, and early constructivist style for teacher actions. Didactically, the environment of the classroom

Table 12

***TPPI* Interview Codes and Transcript Statements for Nathan (T5)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	Reasons not able to do inquiry: “school schedules supervisory demands, and administrative constraints.” physical environment of the class was stressed in not forgetting “materials, books, and being punctual.”	Threaten them to work “forgetting materials, forgetting books is grounds to get it basically a demerit or behavioral action form”	“hands-on stuff is a function of class size” assessment such as “quizzes and stuff”
Transitional	What is needed for the classroom is a “lot of structure and consistency for one day to the next and to cut down on confusion.”	“fear plays a large role in manipulating the educational environment”	class should be “relaxing . . . and enjoyable.”
Conceptual			“the lower kids are actually getting this stuff and working out answers” students share with others as in “peer tutoring”
Early Constructivist			the students “like to be talked to, communicated with”

was stated as a method in maximizing student understanding. Transitionally, Delaine stressed the importance of teacher organizational skills. Delaine believed in having the students experience excitement and pride in their work, even when learning from failing attempts. Delaine believed in early constructivist teacher actions by utilizing stimulus to get students involved, but not off task. She asked higher order questions, set up learning stations, offered variety of methods, and attempted to increase student confidence.

Student actions were mostly conceptual; however, some were didactic/transitional and early constructivist. Didactically, Delaine believed that honors biology classes learned best from hearing her lecture, reading the assigned materials and transcribing her lectures. Transitional student actions included student assessment on an individual basis. Conceptually, Delaine believed the students enjoyed labs, class debates, models, analogies, concept maps, and open-ended discussions. Material was presented to students in visual, written, model, and verbal format. Delaine believed in early constructivist "jigsaw" method of teaching where each student becomes an expert in one area and then acts as teacher of that specific area. For example, each student became an expert in a genetic disorder by researching the disease, and then each student taught the class members about the disorder.

Delaine's philosophy was entirely early constructivist as she believed in utilizing inquiry-based learning techniques in her classroom where she gave students materials and guided them through a three and half week period of research. During the student research, Delaine believed in asking probing questions to acquire the student reasoning that preceded student action. She noticed student interest during the discovery and growing of mold spores, and she also encouraged students to learn from their past experimental failures. Refer to Table 13 for Delaine's supportive transcript quotes.

Table 13

***TPPI* Interview Codes and Transcript Statements for Delaine (T6)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	"Using the walls and stuff for lost of review-types stuff, kind of visual-type quizzes" "I have stuff hanging from the ceiling, couple of DNA, replication." "I used to have animals in here."	"My honors class for some reason, their major learning styles are auditory, reading and writing, they will all write down every thing I say and then rewrite their notes and that is how they say they learn best."	
Transitional	Classroom is "very put together, everything in proper order." "Everything should be in its proper place, try to avoid things from getting too dirty, too disorganized."	"I walk around and individually assess" students.	

Table 13 (Continued)

***TPPI* Interview Codes and Transcript Statements for Delaine (T6)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Conceptual	"there is usually a lot of excitement, especially when we start looking at it under the stereoscopes." "they were so proud of themselves and they did so good on that project." "even in the failure in not realizing it needed water, they learned a lot"	The students like labs, and "get a kick out of class debates" "the CP class learns a lot more with the kinesthetic stuff" The students do lots of models, analogies, concept maps; "I always do a couple of activities." The students like "open-ended discussion." "I always have visual examples, I always repeat it auditory, I always show them written stuff, use models." "usually have a couple of activities for the kinesthetic learners."	
Early Constructivist	"A lot of stimulus in the classroom to keep the student's attention but not enough to actually get them off focus and off topic" doing more questioning with inquiry activities, "coming up to everyone individually and asking why are you putting that in that container" "you have to tell them whether there is no one correct answer. " "There are many, many different ways that you can do this and set them up." I "try to increase student confidence." "I set up stations where they have to mover around the room. "You go to different areas, look at stuff more as an investigative approach."	The students do "a lot of jigsaw, kind of with the expert groups" "jigsaw stuff to help them with peer tutoring situations"	"I like most as far as teaching is more students and their inquiry-based learning." "I give them a whole bunch of materials and they have to do two experiment through the three and half week period." "They can see a lot of them in there with the spores and lots of different varieties and that really interests them." "I always do lots of open-ended questions, lot of probing questions to get them to think." teacher asks "why do you think that and why did they do this"

Lucy (T7) exhibited teacher actions across didactic/transitional and conceptual styles. She felt that her classroom tactics were hindered because of management issues and time constraints. She stated that it was especially hard to keep the basic class managed and that she would do labs in some other classes that she would not do in her Basic classes. Notes were provided on typed overheads for lectures. She believed the classroom environment should be orderly with classroom procedures remaining constant. Her conceptual teacher actions included the use of peer tutoring by having the students helping each other to understand a concept.

Student actions in Lucy's class were predominately didactic as "practice" was stated as the best course of action to understanding. She believed students, especially the lower students, learned best by having information repeated. Quizzes were used to reinforce Lucy's desire for students to look through their notes. Lucy believed the students were not self-motivated to do so on their own. A conceptual student action was that the class had varied activities from more difficult to less difficult so everyone could have a chance to succeed.

Lucy's philosophy was predominately didactic/transitional. She repeated the theme of practice and drill by stating that the students have study guides in order to do *repetitive stuff*. The structure of her class was taking notes, doing activity, and then more practice. A conceptual idea arose when Lucy authenticated a metric unit by including the current winter Olympic games within the explanation of unit conversions. Refer to Table 14 for Lucy's supportive transcript quotes.

Table 14

***TPPI* Interview Codes and Transcript Statements for Lucy (T7)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	"If you have 31 basic kids in the class, it is hard to that type of thing . . . . it's just hard to keep the class managed enough for them." "it takes a lot of time outside of class for the teacher to come up with activities and stuff like that." "I would do some labs with another class that I probably wouldn't with the (low level) because they would be sort of fighting with meter sticks you know if you turned your back." "I use overheads for my notes. I try to type them big so they can see them, especially from the back of the room."	"practice seems to be the best way that the students pick up most of it." Students learn best by "practicing it repeatedly I think, especially lower level kids." "I do note quizzes like twice a week where they have to go back and look through their notes, because if you don't do that, they won't do that." I know students have understood a concept "just by their response in the classroom. If they are having a hard time with something, they will ask you 900 questions."	"you have to keep in check at first with tests, quizzes, projects outside of class they do" "I do study guides where they read the book and then I go over them – you know kind of do repetitive stuff that meets special needs." My greatest learning situation occurred because "we kind of got along and were a little bit alike." Students should "take notes, do activity, do some practice, keep things varied, not just always doing on thing the whole period I guess is the best thing."
Transitional	"teacher needs to be organized" "don't want to have the trouble makers sitting together" "keeping things the same as far as where they turn in assignment."		
Conceptual	"I use a lot of peer tutoring" "I use peer tutors to help because if you put a high level with a low level, when there are 31 kids and only one teacher, you know they can help each other." "peer tutoring"	"Vary activities from high to low . . . . one day we will take notes and one day we will draw a picture or do a collage out of magazines that kinds goes so even the lower level kids can do activities like that."	"Today I am doing a little activity on the metric system and I pulled out some activities where you measure, get the mass and volume of things and I tied it in with the Olympics because they are next."

Eileen (T8) discussed actions across didactic/transitional and early constructivist styles for teacher actions. Didactically, she felt facility space was the biggest constraint in conducting more labs. Transitionally, Eileen believed that she had to be organized and creative. For instance, due to her limited class space, she took her students to the gym to do activities. Her actions exhibited early constructivist style by doing as many hands-on activities as she could within the realm of laboratory safety.

Eileen's student actions exhibited transitional, conceptual, and early constructivist style. Transitionally, students were expected to have a reading and writing aspect to most assignments. Conceptually, she believed student understanding took place when the students went beyond the scope of the lesson by asking critical thinking questions. Eileen displayed early constructivist views by realizing that students learn in several different ways.

Eileen's philosophy of teaching was conceptual in that she personally experienced an authentic inquiry-based island environment and then decided to give her students the same opportunity. She believed learning science should be fun; therefore, she continues to take her students to Dauphin island to enjoy an authentic inquiry-based learning environment. Refer to Table 15 for Eileen's supportive transcript quotes.

A simple numerical average was calculated from the *TPPI* data for the teacher's actions and student's actions. To calculate the simple numerical average, an ordinal number ranging between one and six was assigned to each of the following styles: didactic was 1; transitional was 2; conceptual was 3; early constructivist was 4; experienced constructivist was 5; and constructivist inquiry was 6.

Table 15

***TPPI* Interview Codes and Transcript Statements for Eileen (T8)**

	Teacher Actions	Student Actions	Philosophy of Teaching
Didactic	"The facility is my biggest constraint. If I had a laboratory, I feel like I would be able to do more labs."		
Transitional	"The teacher has to be organized." "go to the gym to do activities" get the students "out of here to do creative things"	Students also have a "writing and reading aspect" to assignments.	
Conceptual		Students understand "when they go beyond the scope of the lesson" and "when they ask critical thinking questions."	"I take them to a barrier island for inquiry learning – I have had a blast and it is fun." 'Best teaching was with an oceanography class where we went to Dauphin Island, which had labs, hands-on stuff and had seminars. It was fun and then I do the same thing with my students."
Early Constructivist	"Being creative – I still try to do as much hands-on stuff that I possibly can but I still have to go within the constraints of laboratory safety"	"Students learn in several different ways"	

An average was determined from the *TPPI* for each participant's teacher and student's actions (see Chapter III pp. 78-79 for details in determining average). The averaged data from the ordinal scale were represented as a number. The data descriptor term *wobble* was utilized to signify a score between the ordinal values. A number between 1 and 2 was reported as 1/2; a number between 2 and 3 was reported as 2/3, and a number between 3 and 4 was reported as 3/4. Value 1/2 signified a participant's *wobbling* between the didactic and transitional style; the value 2/3 signified the participant's *wobbling* between transitional and conceptual; while, the value 3/4 signified participant's *wobbling* between conceptual and early constructivist. By using *TPPI* data Tables 8-15, a numerical average for teacher's actions (TA) and student's actions (SA) was determined. Each participant's *TPPI* averaged value for TA and SA is provided in Table 16. Figure 2 contains graphed representations of the data in Table 16.

Of the fourteen selected *TPPI* questions, five questions elicited responses regarding university preparation coursework from both the College of Liberal Arts and the College of Education. The participant response information was relevant to Research Question 2. The five questions were:

1) Which of your undergraduate/graduate education courses were beneficial to you when you began teaching? Why or why not?
2) Which of your undergraduate/graduate education courses were not beneficial to you when you began teaching? Why or why not?

Table 16

Participant *TPPI* Codes Where 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist, and 6=Inquiry Constructivist

Teacher Number	Teacher Name*	*TPPI* Teachers' Actions	*TPPI* Students' Actions
T1	Richard	3/4**	2/3
T2	Susan	2/3	2/3
T3	Tanya	2/3	2/3
T4	Nancy	2/3	2/3
T5	Nathan	1/2	1/2
T6	Delaine	2/3	2/3
T7	Lucy	2	2
T8	Eileen	2/3	3

Note. *Pseudonyms replace actual teacher's names. **Values written with slash indicate participant score wobbles within range of listed numbers.

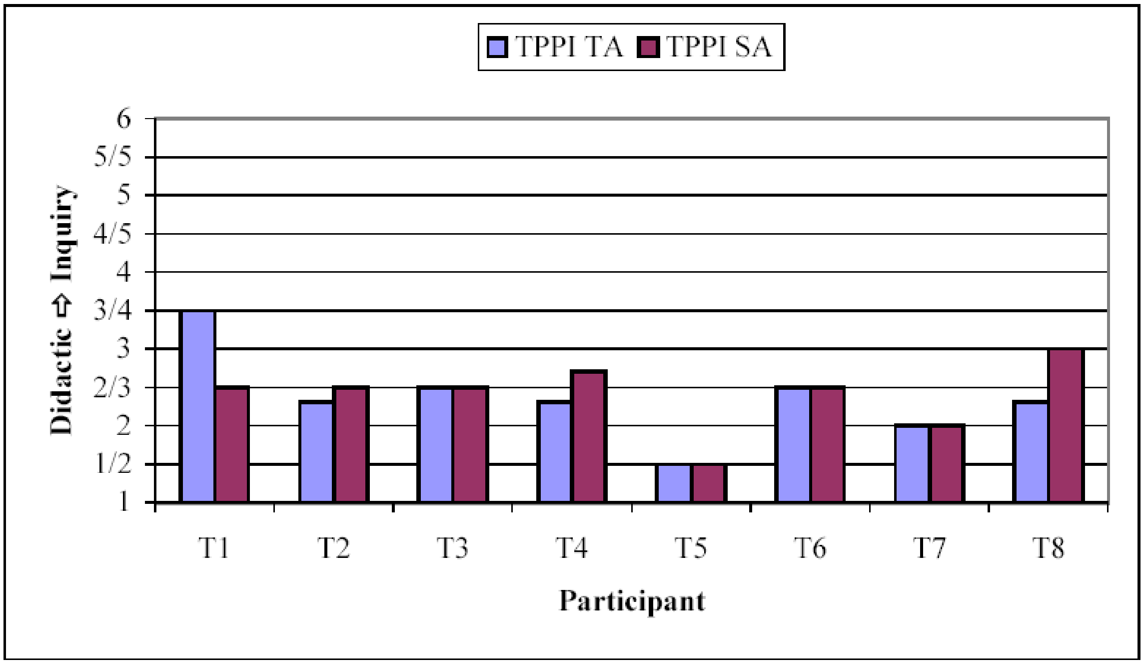

Figure 2. *TPPI* data representation for each participant's teachers' actions (TA) and students' actions (SA)

3) Which of your undergraduate/graduate science courses were beneficial to you when you began teaching? Why or why not?
4) Which of your undergraduate/graduate science courses were not beneficial to you when you began teaching? Why or why not?
5) What changes would you make in undergraduate/graduate education courses to make the experience more meaningful?

Questions 1-4 elicited responses from participants concerning the courses that were most beneficial and least beneficial when they began teaching. The teachers were asked to reflect upon all College of Liberal Arts (Questions 3 and 4) and College of Education (Questions 1 and 2) coursework. Question 5 elicited comments regarding any modification to the teacher preparation experience that would enhance their experience and preparation. All participants completed educational coursework and received their licensure from the University of Tennessee (UT). Two of the eight participants attended

UT for undergraduate science coursework; six participants received their undergraduate degrees from other institutions. However, most of the participants responded to the questions regarding their science coursework from courses they had taken at UT while acquiring their licensure to teach science.

Summation data of participants' responses to the five *TPPI* questions are provided in Table 17. Subsequent to Table 17 are participants' statements regarding rationale and criteria for the selection of *Knowing and Teaching Science: Just Do It* course as beneficial. Both Table 17 (Participants' Reactions to College of Education and College of Liberal Arts Coursework) data and participant statements are used to answer Research Question 2.

Research Question 2: How have these same teachers' practices and beliefs been influenced by the University of Tennessee science teacher preparation program?

Since all participants had completed the Botany 531 course and since it is a key course in inquiry-based instruction*, Knowing and Teaching Science: Just Do It*, the students' rationale for selecting it as one of the most beneficial courses is included. All of the participants listed the course as being one of the most beneficial courses that prepared them when they began teaching. Some participants perceived the course as a College of

Education course; while, some perceived the course as a science course under the College

Table 17

Participants' Reactions to College of Education and College of Liberal Arts Coursework

	Most Beneficial Courses	Least Beneficial Courses
College of Education Course Title	Botany – Knowing and Teaching Science: Just Do It (5) Education in Cultural Prospective Biodiversity Professional Internship Field Experience Chemistry and Society Professional Studies: Teachers, School, and Society Professional Studies - The Learner	None Child Psychology The Disadvantaged Student: Psychoeducational Perspectives Psycho-Educational Studies Professional Studies – The Learner Computer Applications in Education Developing Reading Skills in Content Fields Teaching Science Grades 7-12
College of Liberal Arts Course Title	All courses General Biology (3) Botany - Knowing and Teaching Science: Just Do It (3) Darwin Day (2) Biodiversity Geology Chemistry (2) Physics (2) Aquatic Ecology Cell Biology General Genetics Ocean Beach and Estuarine Ecology Education and Ornithology and Beach Processes General Entomology Organic Chemistry Biochemistry Comp. Invert. Zoology	None (5) Immunology Neurobiology Anatomy/Physiology Organic Chemistry Plant Evolution Physics

Note. Values enclosed in parentheses represent the number of times the course was selected.

of Liberal Arts. In either case, the rationale varied for the course selection. The following list includes direct supportive transcript responses for participants' rationale in selecting the *Knowing and Teaching Science: Just Do It* course as most beneficial:

1. . . . student questioning and developing that kind of thinking – science is not just memorizing and learning how to outline and know vocabulary. You want your kids to be questioning and curious

2. It helped me a lot just to kind of sit down and see how I could get them to kind of find out what something is with the scientific method. If I hadn't taken that class, I wouldn't have felt comfortable doing that kind of stuff – just giving them stuff and have them go at it.

3. It was the best one to show about inquiry.

4. It was an example for all you know - I can tell the kids about the lab experience and you know the inquiry that we did and stuff like that's good for examples.

5. The whole inquiry thing – didn't even know what inquiry was at all before that class and was forced to figure it out…You follow step by step but you don't really think about makeup of experiments, and I really didn't know until then, so that helps now in carrying them out in my own class.

6. I had always heard about inquiry but I hadn't done it myself and so that was good, actually seeing the frustration yourself, understanding what it is like to feel like a complete moron. And then have no confidence, then get your confidence back and then feel good about yourself. Because I remember at first when we went in there, we were like a lot of us were saying I have been in Biology courses the whole entire time I have been and college. *Why can I not figure this out? Why am I such a retard?* So that was good because it shoved you back on the teacher's perspective, I mean on the student's perspective . . . . Since I was going to do inquiry and expect a lot out of them, I needed to be aware of what they may be feeling. Instead of being like *Gosh, why are you feeling like an idiot?* It is ok if you feel like an idiot. You probably will. It is normal.

7. A lot of neat ideas with the inquiry *Just Do It* course. Neat ways to get kids to work and get problems on their own, having them come up with or construct their own ideas of what they need to be doing and let them figure out their own way and so those were probably the most beneficial, the most impact.

8. I laugh about it sometimes, because I can tell I have got the Hickok thing working. (laughter) When I ask these questions and they get so frustrated I would ask them a

question and they would go *we don't know, what is the answer, we don't know, we don't know* and I would say *keep thinking about it*.

9. It made me see the importance of thinking for yourself and not expecting to get the answer from the teacher.

Observational Data

The *STAM Record of Activity* sheets were utilized to code each participant's observational data (see Appendix D for *STAM* Analysis of Video). Each participant's three-hour classroom observational information was recorded on the *Record of Activity* sheet, which included dates, times, transitions, and activities (see Appendix E for participants' *STAM* records). The observational data were coded utilizing a matrix of five major categories: content, teacher's actions, student's actions, resources, and environment. Within the matrix, the five major categories were further subdivided into twenty-two subcategories. Table 18 and Figure 3 display the five major *STAM* categories as they correspond to the twenty-two subcategorical items.

The researcher and assistant individually coded each participant's observational data within the twenty-two sub-categories under the teaching style headings didactic, transitional, conceptual, early constructivist, experienced constructivist, or constructivist inquiry.

Table 18

***STAM* Categories and Subcategories**

Major Category	Subcategory by Number
Content	1. Structure of Content 2. Use of examples and connections 3. Limits, exceptions, and multiple interpretations 4. Processes and history of science
Teacher's Actions & Assessment	5. Teaching methods 6. Labs, demonstrations, and hands-on activities 7. Teacher-student interaction 8. Teacher questions 9. Kinds of assessment employed 10. Uses of assessment beyond grading 11. Teacher's responses to students' ideas
Student's Actions	12. Writing and other representations of ideas 13. Students' questions 14. Student-student interactions 15. Student-initiated activity 16. Students' understanding of teacher expectations
Resources	17. Richness of resources 18. Uses of resources 19. Access to resources
Environment	20. Locus of decision-making 21. Teaching aids displayed 22. Students' work displayed

Source: Salish I Research Project Supplement, 1997, *Secondary science and mathematics teacher preparation programs: Influences on new teachers and their students; Instrument package and user's guide*, 123-124. Copyright 1995 by J. Gallagher & J. Parker. Used with permission of the author.

STAM Analysis Record - Science Version

Secondary Teacher Analysis Matrix - Science Version
J. Gallagher & J. Parker
May, 1995 © Revised October, 1995

	TEACHING STYLE	A. DIDACTIC	B. TRANSITION	C. CONCEPTUAL
CONTENT	*1. Structure of content*	*factoids*	*descriptive*	*explanatory*
	2. Examples & connections	none	not integrated	made by T
	3. Limits, exceptions, & multiple interpretations	*not present*	*some included not integrated*	*part of content*
	4. Processes & History of science	rote scientific method	not integrated	integrated by teacher
TEACHER'S ACTIONS	*5. Methods*	*1 or 2 T-centered*	*3 or 4 T-centered*	*many T-centered*
	6. Labs, demos, hands-on	rare	cookbook or undirected	conceptually focused
	7. T-S interactions about subject matter	*little*	*about unconnected ideas*	*about conceptual content*
	8. T's questions focused on...	factual recall	unconnected ideas	concepts & connections
	9. Kinds of assessment	*tests & quizzes only*	*occasionally others*	*frequently others*
	10. Uses of assessment in addition to grading	none	checking Ss' knowledge	checking Ss' knowledge & preplanning
	11. T's responses to Ss' ideas about subj. matter	*disregards*	*accepts all ideas*	*seeks to change unscientific ideas*
STUDENTS' ACTIONS	12. Writing & other representations of ideas	short answers	different reconfigurations of info. provided: rare	several
	13. Students' questions	*few*	*procedural*	*procedural & conceptual*
	14. S/S interactions about subject matter	rare	about procedure	about correctness
	15. Student-initiated activity	*Ss volunteer examples: rare*	*few*	*some*
	16. Ss' understanding of teacher's expectations	Ss passive or ignore procedures	confusion over procedure	expectancies accepted
ENVIRON. RESOURCES	*17. Richness of resources*	*little beyond single format*	*small number, some hands-on*	*multiple*
	18. Uses of resources	looked at only, not related		related to ideas
	19. Access to resources	*T-controlled*		*some discussion*
	20. Decision making	T-dominated	T-controlled	some discussion of time use
	21. Teaching aids	*few (may not be integrated w/ content)*	*some*	*many, related to content*
	22. Students' work displayed	similar from all Ss: few	some	many

Figure 3. Secondary Science Teacher Analysis Matrix

Source: Salish I Research Project Supplement, 1997, Secondary science and mathematics teacher preparation programs: Influences on new teachers and their students; Instrument package and user's guide, 123-124. Copyright 1995 by J. Gallagher & J. Parker. Used with permission of the author.

Date of Analysis:
Teacher:
Analyst:

D. EARLY CONSTR.	E. EXPERIENCED CONSTR.	F. INQUIRY		
T & Ss negotiate understanding		investigations dominate	1	CONTENT
T's content	based in content & Ss' ideas			
lead by T	constructed by T & Ss	constructed by Ss	2	
identification & use		as part of problem solving	3	
lead by T	constructed by T & Ss			
use of process to formulate ideas		applied to investigations	4	
lead by T	constructed by T & Ss			
S-centered		question dependent	5	TEACHER'S ACTIONS
some	extensive			
build on Ss' ideas			6	
lead by T	constructed by T & Ss	guided by question		
clarification & usefulness of Ss' ideas		S input into goals	7	
T-directed	T & Ss have input			
emerge from Ss' ideas & instr. goals			8	
occasionally	frequently	guiding investigation		
multiple forms of assessment			9	
of knowledge & understanding	mainly of understanding	arise from investigation		
adjusting activities		T & Ss designing investigation	10	
by T	by T & Ss			
considers in instr.. decisions	assessment drives T's decisions	T is co-investigator w/ self-directed Ss	11	
Ss use to construct meaning			12	STUDENTS' ACTIONS
occasionally/some reconfig.	frequently	Ss choose form		
some conceptual, some procedural	mainly conceptual	conceptual, applied to investigation	13	
some about procedure	about understanding	about understanding & planning	14	
some about understanding				
Ss contribute examples and analysis			15	
may be weakly connected	pertinent	guide class direction		
frustrations w/ role	role & procedures negotiated w/ Ss	Ss define role	16	
multiple resources			17	RESOURCES
aid understanding & application		integrated into investigation	18	
some	many			
T-guided	negotiated by T & Ss	guided by question	19	
joint decision making			20	ENVIRON.
some	much	applied to investigation		
made by Ss			21	
some	many	derived from investigation		
Ss' creations			22	
some	many	derived from investigations		

Figure 3. (Continued)

STAM co-authors Duggan-Haas, Gallagher, and Parker (2001) defined the six teaching styles as follows:

> **A. Didactic Teaching** is teacher-centered teaching, in a highly teacher-directed environment. Fact-centered information transfer is the key goal. Assessment only serves grading and it is designed to determine if students "received" the information that was "transmitted." Students are largely passive recipients of information, and didactic teachers have very limited concern about student's ideas and reasoning in their preparation and delivery of the information.
>
> **B. Transitional Teaching** shows attributes of both didactic and conceptual. Content is less fact-centered and more elaborated than in didactic teaching. Teachers' actions exhibit more attention to students' reactions to their presentation. There will be a greater incidence of teacher-student interaction about content than in didactic teaching. For example, lecture-discussion typically replaces straight lecture in this model of teaching. Assessment will have only very limited uses beyond assignment of grades. The environment and resources will remain essentially teacher-centered and teacher directed. The intention often is the same as with didactic teaching – to "cover science content," but to do so in more engaging, interactive manner. This instructional mode is frequently seen in secondary classrooms as teachers present information to students and then ask them questions about it or respond to students' questions.
>
> **C. Conceptual Teaching** content is concept-centered instead of fact-centered. Relationships among facts and ideas are more central. Teacher's actions focus more on aiding students in developing understanding of relationships and connections. Teachers give more attention to students' ideas and reasoning, and they use assessment as a tool for diagnosing students' understanding instead of only using assessment to allocate grades. Teacher-student interactions focus on nurturing the development of understanding of science concepts and students' reasoning about and from them. However, the setting tends to be strongly teacher-directed in its nature and in the physical setting and use of resources.
>
> **D. Early Constructivist Teaching** shifts from a teacher-centered to a student-centered approach. Students' ideas and reasoning become a much more central part of the interaction between students and teachers. Assessment takes on a more central place in the instructional process as teachers strive to understand students' ideas and reasoning processes, and the content and pace of instruction is altered somewhat by this

information. Often the physical setting of the classroom is altered to allow students to work in groups more frequently. Moreover, group work, which in other paradigms of teaching has a limited social-interactive focus, now assumes the role of helping students collaborate to support each other's emerging understanding and application of science concepts. In addition, writing will be more evident in most constructivist classrooms.

E. Experienced Constructivist Teaching of content brings a greater increased conceptual emphasis than is typically seen in early constructivist teaching as teachers become more effective in guiding students to deeper understanding of science concepts and their interconnections. Teachers are more concerned about students' understanding of instructional content and less about the procedures and form of instruction, as they develop greater facility with implementing student-centered instructional methods. Continuous, embedded assessment is a central part of this approach because teachers must understand students' ideas and reasoning in order to determine instructional activities. Much more responsibility and control of learning is given over to students, but teachers also provide careful and continuous monitoring of students' progress toward learning goals.

F. Constructivist Inquiry Teaching is characterized by instruction operating in the mode of self-sustaining inquiry. Student-centered inquiry lies at the heart of both content choice and method. Teachers serve as guides to students as they carry out their investigations typically working either individually or in small groups. Frequently, many different investigations are in progress in a classroom at any time, as students explore specific questions that derive from the line of inquiry that governs the class. The classroom has the "feel" and the appearance of a research group at work. Whole class discussions occur occasionally as students present their work to peers and the teacher who critique it. Some class time may be devoted to learning new techniques for data collection and analysis or deepening understanding of relevant scientific concepts. However, the preponderance of time is devoted to carrying out investigations, organizing and analyzing data, writing summaries and reports, and reflecting on subsequent inquiries (pp. 8-11).

In conjunction with each participant's *Record of Activity* data sheets, a six-paragraph *Video Portfolio Summary* was completed elaborating the coding details for each of the twenty-two *STAM* subcategories. The *Video Portfolio Summary* consists of one overview paragraph and five paragraphs representing the categories of content, teacher's actions, student's actions, resources, and environment. Following each of the participant's summary paragraphs is a table visually displaying the *STAM* graphic summary codes. The *Record of Activity Sheets*, the *Video Portfolio Summaries*, the *STAM* Tables 19-26 (Participant's Graphic Summary Style of *STAM* Subcategories) and Table 27 **(**Participant *STAM* Codes Where 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist, and 6=Inquiry Constructivist), and Figure 4 (*STAM* data representation for each participant's content, teacher's actions, student's actions, resource, and environment) are used to answer Research Question 3.

Research Question 3: What are the teachers' observable practices in the classroom and how do these teachers' classroom practices align with inquiry instruction?

STAM Video Portfolio Summary

Each participant's *Video Portfolio Summary* consists of six paragraphs under the subheadings overview, content, teacher's actions, student's actions, resources, and environment. Values enclosed in parentheses within the overview paragraphs indicate the frequency with which the category was selected. Following the participant's *STAM Video Portfolio Summary* is his/her *STAM* Graphic Style Summary Table.

STAM Video Portfolio Summary for Richard (T1)

Overview.

The two 90-mintue class sessions focused on chemical structure, function, and properties as related to organic compounds. The class sessions were dominated by transitional (9.5) and conceptual (7.5) styles with a few didactic (3) and early constructivists (2) styles, as shown in Table 19.

Content.

1B. The structure of the content was descriptive with text facts given equal emphasis to concept. 2B, 2C. The teacher utilized real-world examples and connections to the concept, which involved the various types of gases found in Bunsen burners, household gas lines, and manufactured lighters. Aromatic compounds were connected to odor of wintergreen lifesavers and mothballs. Teacher referenced the use of the terms "unsaturated and saturated" with regard to fat grams. 3A. Limits, exceptions, and multiple representations were not included. One correct answer was required with the student- built models, note sessions, and quiz items. 4C. Observational process of science was included with scientific concepts during the burning of paper and bread and during the smelling of aromatic lifesavers and mothballs.

Teacher's actions.

5B. The teacher employed teacher-centered methods during note-taking and quiz sessions. Hands-on activities included organic structure model building and organic material burning; however, these methods were directed by laboratory sheets and searched for one correct answer. 6C. Demonstrations and lab exercises were utilized with answers generally known ahead of time. 7C. Teacher-student interaction was mostly about correctness of students' ideas. 8B. Teacher's questions focused on deriving right-answer from students' responses. 9C. Teacher monitored student

Table 19

Richard (T1) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1		■		
	2		■	■	
	3	■			
	4			■	
Teacher's Actions & Assessment (5-11)	5		■		
	6			■	
	7			■	
	8		■		
	9			■	
	10		■		
	11			■	
Student's Actions (12-16)	12	■			
	13		■		
	14		■		
	15		■		
	16			■	
Resources (17-19)	17			■	
	18				■
	19				■
Environment (20-22)	20		■		
	21		■		
	22	■			

activities throughout lessons by asking questions concerning what students *noticed* during the lab. 10B. Student's knowledge was assessed during monitoring, question/answer, and formal quizzes. 11C. Teacher responded to students' ideas by repeating student responses as valid answers.

Student's actions.

12A. Writing consisted of short answers as students completed lab sheet, answered quiz questions, and completed teacher-prepared note pages. 13B. Student questions were predominantly procedural and clarifying such as *what is the chemical structure*? and *are we doing this together*? 14B. Student-student interaction was mostly social with some procedural questions such as *where did you get isobutene*? Student replied with *it shows it in the book*. 15B. Students volunteered examples while smelling mothballs 16C. Most students accepted role of procedures in class. Teacher did elicit one student's response and continued asking questions until the student seemed frustrated with an *I don't know* response.

Resources.

17C. Resources included visual aids, laboratory materials, and teacher-constructed worksheets. 18D. Resources are related to the content. Students applied their own ideas during the construction of models, burning of carbon items, and smelling of aromatic carbons. 19D. Teacher guided access to resources; however, students were allowed to sit anywhere in class or lab and borrow each other's materials when needed.

Environment.

20B. The teacher made most of the classroom decisions without student input. 21B. Some teaching aids were displayed relating to various aspects of biology and chemistry. 22A. Students work was not displayed. Teacher instructed students to dispose of their marshmallow and raison models in the trashcan.

STAM Video Portfolio Summary for Susan (T2)

Overview.

The two 90-minute class sessions focused on student's understanding of DNA, mutations, enzyme function, and phenotype. The lessons concluded a four-week unit on DNA structure and function. The class sessions were dominated by conceptual (9) style with an approximately equal marking among didactic (5.5), early constructivist (4), and transitional (3.5) styles, as shown in Table 20.

Content.

1A. The content structure was conceptual utilizing an explanatory approach. The students displayed the process that DNA determines phenotype by using the functioning and nonfunctioning enzymes. 2A, 2B. Real world examples were used to show how enzymes in the body become functioning or nonfunctioning. 3A. Limits or exceptions were not presented during either lesson. 4A. The process or history of science was not discussed.

Teacher's actions.

5D. The teacher utilized an enzyme lesson from the *American Biology Teacher* journal and had students work both days in cooperative groups. Concept mapping and

Table 20

Susan (T2) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1			■	
	2	■	■		
	3	■			
	4	■			
Teacher's Actions & Assessment (5-11)	5				■
	6			■	
	7		■		
	8				■
	9				■
	10			■	
	11			■	
Student's Actions (12-16)	12				■
	13		■		
	14		■		
	15	■			
	16	■			
Resources (17-19)	17			■	
	18			■	
	19			■	
Environment (20-22)	20			■	
	21			■	
	22	■			

student discussion were utilized in both classes. 6C. A hands-on activity included the determination of the enzyme function. The lab was conceptually based as the students determined the enzyme's function from flipping plastic tiles that represented alleles of DNA. 7B. Most of the teacher-student discussion was concerning procedural aspects of the assignments. 8D. Teacher's questions were higher order questions; however, student confusion concerning procedural matters prevented students from responding. 9D. Multiple forms of assessment were utilized; assessment included concept maps, group work, homework, quizzes, presentations, and projects. 10C. Frequent monitoring of student's understanding during activity and frequent grading of course assignments were utilized for assessment measures. 11C. Teacher responded to student's ideas as legitimate and worked to alter any unscientific ideas.

Student's actions.

12D. Student representation of ideas was in the form of concept maps, drawings, notes, and presentations. 13B. Student questions were mostly procedural. 14B. Most student-student interaction was social. Class-related student-student interaction concerning subject matter was procedural and clarification. 15A. Students rarely volunteered examples or analysis during class sessions. 16A. Most students ignored teacher's procedures or requests. Approximately half of the class was not engaged in appropriate scientific activity during any given time frame; most students socialized unless teacher was assisting with their particular group.

Resources.

17C. Multiple sources of materials were utilized including professional journals, computer technology, laboratory materials, and visual aids. 18C. Resources utilized by students included worksheets, tape, tiles, transparency paper, and markers. 19C. Teacher controlled access to resources by distributing all materials to students on a needed basis.

Environment.

20C. The environment and decision making was teacher controlled with some decisions allocated for students with regard to use of time. 21C. Teaching aids included posters and manipulatives that were related to the content. 22A. Student work was not displayed in classroom.

STAM Video Portfolio Summary for Tanya (T3)

Overview.

The two 90-minute class sessions focused on genetic principles concerning pedigrees and inheritance patterns of sex-linked, dominant, recessive, incomplete dominant, and multiple allelic traits. The class sessions were dominated by a conceptual (11.5) style with a few early constructivist (4.5), didactic (3), and transitional (3) styles, as shown in Table 21.

Content.

1B. The content was factually oriented with descriptive problems and scenarios underscoring the genetic principles. 2C. Examples and connections to real world events such as transplant, genetic counseling, and blood donor procedures were included. 3A. Limits or exceptions were not included. Statements were made as absolute answers. 4C.

Table 21

Tanya (T3) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1		■		
	2			■	
	3	■			
	4			■	
Teacher's Actions & Assessment (5-11)	5			■	■
	6			■	
	7				■
	8			■	
	9				■
	10		■		
	11			■	
Student's Actions (12-16)	12		■		
	13			■	
	14			■	
	15			■	
	16			■	
Resources (17-19)	17			■	
	18				■
	19				■
Environment (20-22)	20			■	
	21	■			
	22	■			

The process of science was included during the student's observation of phenotype (observable) traits in determining their own genotype.

Teacher's actions.

5C, 5D. Teacher-centered methods during note-taking presentations as content was delivered on screen and students wrote down information. However, the teacher solicited student questions and answers frequently during the presentation. Student group work and discussion was prevalent during both class sessions. 6C. Activities were conceptually focused as students applied inheritance knowledge in determining pedigree and genotypes and in solving genetic word problems. 7D. Teacher-student interaction was based upon understanding of concepts. Student's discusses and analyzed pedigrees and patterns of inheritance openly. For example, one student stated that the square symbol signifying a male on the pedigree could never be half shaded in sex-linked traits. The teacher responded by repeating the student's idea followed with the statement *good point*. 8C. Teacher's questions during note sessions asked for some factual information; however, most teacher questions asked for connection of ideas with questions such as *how is incomplete dominance different from co-dominance*? 9D, 10B. Multiple forms of assessment were utilized including student reports, homework, tests, and quizzes. Teacher monitored class sessions by asking non-volunteers and volunteers to give responses both verbal and written for class discussion. 11C. Teacher solicited student explanation about ideas and responded with *good reasoning* and *good point*.

Student's actions.

12B. Writing and other representations were occasionally utilized, such as with the pedigree drawings. Although, most student representation of ideas was short answers on worksheets. 13C. Student questions focused on clarification and meaning related to the genetic concepts. For example, a student asked *if a particular individual on a pedigree could pass on a trait*? and *if hemizygous was the same as homozygous*? 14C. Student-student interaction was predominantly about procedure and completing the assignment. Some student-student interaction involved analysis of coin-flipping probability. 15C. Students did volunteer examples and connections related to concept when completing activities. 16C. Students accepted role and procedures of class setting.

Resources.

17C. Multiple resources were utilized including software technology, white board, internet, and wall posters. 18D. Students utilized resources to aid understanding and apply ideas. 19D. Teacher guided access to resources by requesting students use the board. Students freely sharpened pencils and disposed of personal items without permission.

Environment.

20C. Teacher gave students some control over time during class and offered options of working on various things at end of class. 21A. Teaching aids were few in number. 22A. Student work was not displayed in classroom.

STAM Video Portfolio Summary for Nancy (T4)

Overview.

The two 90-mintue class sessions focused on cellular organelle type and function and differentiation between plant and animal cells. The class sessions were dominated by conceptual (8.5) and early constructivist (8.5) style with a few transitional (2) and didactic (2) styles, as shown in Table 22.

Content.

1C. The content was presented explanatory as the cell size, function, and organelle location was utilized in constructing the 3-D cellular models. 2C. Teacher provided examples and connections to the cellular organelles from analogies of each organelle to various roles within a city structure. For example, the mitochondrion was analogous to the Knoxville Utilities Board in that the mitochondrion supplies power to the cell and KUB supplies power to the city. The ribosome was analogous to a city factory in that the ribosome makes proteins and factories make a certain product. 3A. Limits, exceptions, or multiple representations were not present. Students drew plant and animal cells from text drawing. For example, 3-D model of cellular organelles *must look like picture of organelles*. 4A. The process of science was not observed for the organelle and plant/animal cell lessons. However, students were presumably watering plants for ongoing experiments from another unit.

Teacher's actions.

5C, 5D. Teacher exhibited some student-centered methods by allowing student variety in organelle placement, organelle structure, and cellular design. The drawing of

Table 22

Nancy (T4) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1			■	
	2			■	
	3	■			
	4	■			
Teacher's Actions & Assessment (5-11)	5			■	■
	6				■
	7			■	
	8			■	
	9				■
	10				■
	11			■	
Student's Actions (12-16)	12		■		
	13		■		
	14			■	
	15		■		
	16			■	
Resources (17-19)	17				■
	18				■
	19				■
Environment (20-22)	20				■
	21				■
	22			■	

plant and animal for the paper fan construction was a clear-cut pre-designed activity. 6D. Student's ideas were incorporated in design of 3-D model of the cell. Teacher asked students to *use creativity and imagination*. 7C. Teacher-student interaction was mostly to assist students in determining items to use for organelle representation. Also teacher-student interaction was utilized to determine how to display the item as a certain organelle. The students approached the teacher to display what they had chosen to represent a certain organelle and why they had chosen it. 8C. Teacher's questions focused on content as she monitored room asking students *what they had chosen to represent a certain organelle* and *why they chosen that particular item* for that particular space. 9D. Multiple forms of assessment utilized were project grades, tests, and class monitoring. 10D. Teacher asked questions about cells on previous test to pre-assess student knowledge concerning animal and plant cells. 11C. Teacher elicited student's conceptions about scientific ideas and questioned students further to alter student's perception.

Student's actions.

12B. Students' actions included making original models from text organelle definitions and drawing plant/animal cells from text. Most of the information was a reconfiguration; however, the construction of the 3-D model was student designed. 13B. Students' questions were mostly clarifying and procedural with some content. 14C. Student-student interaction was concerned constructing models and drawing cells accurately. 15B. Students volunteered examples. During teacher explanation on how to conceptualize your own model, one male student stated to the class that the *mitochondria* *looked like a loaf of bread*. 16C. Students accepted role and procedures in class and utilized hot glue gun and all other materials without direct supervision.

Resources.

17D. Multiple resources utilized were visual aids (posters), manipulatives (fishing line, glue gun, various plastic pieces, pipe cleaner), and laboratory materials (watered plants). 18D. Resources were utilized to aid student understanding of concepts and application of ideas. 19D. Teacher guided access to resource; however, students began their projects on day two by retrieving their own materials. Students utilized any material in room and utilized any work-space in room.

Environment.

20D. Students and teacher negotiated decisions. Teacher gave students *option of worksheet or drawing and constructing fanned-cell model*. Teacher told student *you went to bathroom and got a coke, we made a deal*. 21D. Many teaching aids relating to cells were present on walls. 22C. Student work was displayed on bulletin boards and hanging from ceiling.

STAM Video Portfolio Summary for Nathan (T5)

Overview.

The three 55-minute class sessions focused on the process of meiosis and formation of sex cells as related to reproduction. The class sessions were dominated by didactic (12) and transitional (7) styles with a few conceptual (2) and early constructivists (1) styles, as shown in Table 23.

Table 23

Nathan (T5) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1	■			
	2	■			
	3	■			
	4	■			
Teacher's Actions & Assessment (5-11)	5	■			
	6	■			
	7		■		
	8	■			
	9		■		
	10		■		
	11		■		
Student's Actions (12-16)	12	■			
	13		■		
	14	■			
	15			■	
	16			■	
Resources (17-19)	17	■			
	18	■			
	19		■		
Environment (20-22)	20	■			
	21				■
	22		■		

Content.

1A. Didactic content column was presented mainly as question and answer method with the teacher reading the question either from a worksheet, DVD, quiz, or book. Teacher sought one correct answer in question/answer sessions. 2A. Little connection was made to real world events, other than those depicted in text. 3A. No limits, exceptions, or multiple interpretations were included. 4A. No explicit mention of how science concepts were derived.

Teacher's actions.

5A. Three teacher-centered methods predominated – question/answer, DVD viewing, and worksheet practice. 6A. Evidence of demonstrations, labs or hands-on activities was not observed. 7B. Teacher-student interactions were about correctness of students' answers. 8A. Teacher's questions called for factual recall and teacher

responses were replies of right or wrong. 9B. Students exchanged and graded peers' papers on quiz. Grading was numerical for the number of correct responses. Verbal assessment was performed during class as teacher posed questions and students responded. 10B. Student's knowledge was checked via question and answer verbally throughout class session. 11B. Few student-shared ideas about concepts were presented; teacher responded to questions with *don't know* or *outside of my expertise*.

Student's actions.

12A. Most student writing was short-answer format on worksheets. 13B. Most student questions were clarifying procedures and directions. 14A. Student-student interaction was rare concerning scientific content; occasionally socializing among students was present. 15C. Students volunteered a few examples related to reproduction such as dog and mule breeding. 16C. Students accepted procedures and roles. Students raised hands to be acknowledged by teacher to answer questions, sharpen pencil, and exit chair.

Resources.

17A. Resources were primarily from the text, including text worksheets and text supplemental DVD. 18A. Students primarily viewed worksheets, text, whiteboard, and DVD; students had no interaction with materials other than paper, pencil, notebook, and text. 19B. Teacher controlled access to resources; students raised hands to exit seat and retrieve materials.

Environment.

20A. Decision-making was predominantly teacher-centered. 21D. Many teaching aids constructed by teacher were displayed throughout the room. Teacher had enormous artistic talent in drawing and representation. 22B. Some student work was displayed from previous years/previous classes. Class space was minimal.

STAM Video Portfolio Summary for Delaine (T6)

Overview.

The two 90-minute class sessions focused on genetic principles concerning pedigrees and inheritance patterns of sex-linked, dominant, recessive, incomplete dominant, and multiple allelic traits. The class sessions were dominated by a conceptual

(10) style with a few early constructivist (4.5), transitional (3.5), didactic (2), and experienced constructivist (2) styles, as shown in Table 24.

Content.

1B, 1C. Content was transitional to conceptual; facts were presented in conjunction with explanatory evidence of main ideas. The explanation of key ideas included topics not directly related to genetics. Teacher compared blood cell and oxygen use when exercising in lower and higher altitudes. 2C. Examples and connections to real-world events were made often with subjects including Y-chromosome fertilization of the egg, color blindness, Muscular Dystrophy, family histories, organ donations, blood transfusions, and parental inheritance matching. 3B. Few limitations, exceptions, and multiple representations were provided. Teacher discussed information available from pedigrees and that genetic counselors *can tell with the use of pedigrees sometimes*. 4C. Processes and history of science was discussed with current research topics such as inactivation of the X chromosome, chemical coating of egg cell, and the Human Genome Project.

Teacher's actions.

5D. Teacher employed mostly student-centered methods with group work, discussion, presentation, and student writing. Teacher encouraged students to listen to teacher-provided explanation and then paraphrase/translate notes by simplifying them into a few words. Teacher explains that the notes are a *written description of what they just did*. 6C. Hands-on activities, labs, and presentations were utilized with answers

Table 24

Delaine (T6) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Subcat. Num.	A. Didactic	B. Transit-ional	C. Con-ceptual	D. Early Con-struct.	E. Exp. Construct.
Content (1-4)	1		■	■		
	2			■		
	3		■			
	4			■		
Teacher's Actions & Assessment (5-11)	5				■	
	6			■		
	7			■		
	8			■		
	9			■		
	10		■			
	11	■				
Student's Actions (12-16)	12				■	
	13			■	■	
	14	■				
	15			■		
	16			■		
Resources (17-19)	17			■		
	18					■
	19				■	
Environment (20-22)	20		■			
	21					■
	22					■

generally known ahead of time. 7C. Teacher-student interaction was mostly verification of correctness of student- expressed knowledge. Students asked teacher *am I doing this right*? Teacher asked students to *check board and look for mistakes* of other student's answers on the white board. 8C. Teacher questions are directed at student's knowledge and application of concept by asking entire class questions *if 12:4 can be simplified*? and *if someone could live with just one Y or one X chromosome*? Teacher also asked students to notice trends and patterns. 9C. Teacher was actively engaged in monitoring class activities and student performance. Students wrote their answers to problems on white board and explained to entire class. 10B. Assessment measures determined students' correctness. Teacher responded to student answers with "exactly and right." 11A. Teacher responded to students' ideas by expanding some and disregarding others.

Student's actions.

12D. Writing and representation of student ideas included pedigree drawing, genetic report, poster, short answer, problem solving, and paraphrased notes. 13C, 13D. Students questioned teacher about the correctness or rightness of their processes and answers. 14A. Student-student interaction mostly concerned procedure. Student subject matter interaction was mostly with the teacher. 15C. Students volunteered some examples and connections. Student responded to a question concerning the mortality of a person inheriting one X chromosome with the *Turner's syndrome*. 16C. Students accepted roles and procedures of class. Students accepted teacher expectations; students accepted the assigned seats the next class session. The students did not resist the new seating assignment; this new seating arrangement was the expected outcome from their talkative behavior the previous day.

Resources.

17C. Resources utilized included software technology, internet activities, text-supported materials, and related television topics. 18D. Resources were utilized to aid student understanding and application of ideas. Teacher referred to poster of human-mapped genes, relevant television programs, scientific careers, genetic disorders, and currently conducted research. 19C. Teacher controlled access to resources. During one group-work session, teacher instructed students on the distance they could travel to work with a partner by stating they could not work with someone *that is across the room*. Students were allowed to use white board and move around classroom.

Environment.

20B. Teacher determined when assignments were completed. A student asked if the class could get another day for their genetics report and teacher replied, *no, you aren't getting another day.* As a consequence for talking during the first class session, teacher assigned seats for each student at the beginning of the next class session. 21E. A variety of teaching aids related to general science content was displayed in the room including posters, models, bones, tusks, and turtle shells. 22E. Student work was displayed throughout room as posters on walls, cell models on tables, and virus and DNA models from ceiling.

STAM Video Portfolio Summary for Lucy (T7)

Overview.

The two 90-minute class sessions focused on student construction of a “roller coaster” made from clear tubing and a BB bearing. The students utilized two 90-minute class periods in constructing a model where the BB stopped within an inch of the end of the tubing. A successful coaster model was one in which the BB stopped within the last inch of the tubing. The class sessions were dominated by didactic (7.5) and transitional (6) styles with a few conceptual (1.5), early constructivists (2), and experienced constructivist (1) styles, as shown in Table 25.

Content.

The content portion was not coded. The lesson centered on an activity that was not directly tied to physical science content by the teacher or students during the two observed/videotaped class sessions. The students had recently discussed the physical science terminology that was utilized during the roller coaster construction; therefore, terminology and/or vocabulary should not have been a limitation. The teacher assigned each student to write a page *discussing the affect* that seven scientific terms had on the coaster; however, no scientific rationale was discussed during the class session when the students constructed the coaster. Hence, learned science content was not observed. The observed class sessions were predominantly the student’s attempt to accomplish the goal of manipulating the tubing so the BB stopped within an inch of the end of the tubing.

Table 25

Lucy (T7) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Subcat. Num.	A. Didactic	B. Transit-ional	C. Conc-eptual	D. Early Con-struct.	E. Exp. Con.	F. Con. Inqu iry
Content (1-4)	1	NA					
	2	NA					
	3	NA					
	4	NA					
Teacher's Actions & Assessment (5-11)	5				■		
	6		■				
	7	■					
	8	■					
	9		■				
	10	■					
	11	■					
Student's Actions (12-16)	12				■		
	13	■	■				
	14		■				
	15	■					
	16			■			
Resources (17-19)	17		■				
	18		■	■			
	19						■
Environment (20-22)	20	■					
	21		■				
	22	■					

The observers agreed on May 9, 2002 during a collaborative meeting to omit the content section as non-codable for both class observations.

Teacher's actions.

5D. The chosen activity of constructing the roller coaster was student-centered as students worked as team to accomplish goal. 6B. Teacher and students stated that the observed activity wasn't the usual experience in the classroom. The teacher made the statement referring to the inquiry nature of the activity that *it was something that they have never done before in her class*. Student told researcher that this *lab* was the second *lab* they had done this year as of March 7, 2002. The teacher asked the researcher when leaving classroom if the researcher *saw what I wanted to see*. 7A. Student-teacher interaction did not concern the physical science subject matter. The teacher monitored groups and repeatedly asked *how is going down there*? 8A. The teacher's questions during worksheet grading period solicited a single correct response. Students raised hands to verify if teacher would accept anything else for a correct response. 9B. Grading included machine-graded multiple-choice, group grading, and paragraph writing. 10A. Numerical grading was the most prevalent assessment. Teacher's statements often referred to *points being removed* for student's inattentiveness, lack of participation, or incorrect answers. Most students worked for grades with replies such as *please we need 20 points*. 11A. Teacher disregarded students' statements about subject matter. Teacher did not believe students had accomplished the goal of activity unless she personally witnessed it.

Student's actions.

12D. Students were assigned to write a one-page discussion of seven physical science vocabulary words to the activity. Additionally, students drew representations of their roller coaster unsolicited by teacher. 13A, 13B. Student questions were few and were predominantly about procedure. Students questioned if the BB *can roll backward*. 14B. Student-Student interaction was predominantly about constructing the tubing so the BB would stop at allotted point. 15A. Students did not volunteer scientific examples or analysis during construction. 16C. Majority of students accepted role and procedure from teacher. During one instance, a student did not want to participate in observing other group's trials; however, the student did comply with the observation when teacher threatened to take away points.

Resources.

17B. Textbook and the textbook provided supplemental materials were utilized. Chapter 8 vocabulary and essay were part of the activity. Students reported that this was the second lab conducted this semester. 18B, 18C. Students utilized resources; however, the resources were not directly linked to content by teacher or student during two-day observation. 19F. Access to the resources was guided by the desire to accomplish goal of activity. Unsolicited by the teacher, the students utilized many personal items in the coaster model, such as Luck Tiki Charm, makeup, pens, tootsie roll container, bottles of lotion, and suckers.

Environment.

20A. Teacher decided most of the classroom protocol such as length of writing, amount of time, result of experiment, and grades. 21B. Teaching aids included posters and few models; the posters were not related to physical science concepts. 22A. Few examples of students work were displayed in classroom.

STAM Video Portfolio Summary for Eileen (T8)

Overview.

The three 55-minute class sessions focused on observation, classification, and characterization of four types of fungi. The class sessions were equally dominated by an early constructivist (12) and conceptual (10) style of instruction, as shown in Table 26.

Content.

1D. Content was negotiated based upon student observation, drawings, and discussions. 2D. Students constructed connections to key ideas of concepts when determining type of fungi. Student remarked about his fungi drawing that it *is kind of like a whippy thing and might be the fungi version of flagellates*. 3C. Multiple representations were presented as part of the content as each student had their own *idea* of what the fungi looked like and the type it was. One student stated to another student that Sample A did not look like bacon; while, the other student replied *well I think it does and what I say goes*. 4D. Processes of science were included as teacher offered students the opportunity to construct evidence by drawing and observing. Students then formulated scientific ideas about what they had observed to classify the fungi.

Table 26

Eileen (T8) Graphic Summary Style of *STAM* Subcategories

STAM Major Category	*STAM* Sub-Category Number	A. Didactic	B. Transitional	C. Conceptual	D. Early Constructivist
Content (1-4)	1				■
	2				■
	3			■	
	4				■
Teacher's Actions & Assessment (5-11)	5				■
	6			■	
	7			■	
	8				■
	9			■	
	10			■	
	11			■	
Student's Actions (12-16)	12			■	
	13			■	
	14				■
	15				■
	16				■
Resources (17-19)	17				■
	18				■
	19				■
Environment (20-22)	20			■	
	21			■	
	22				■

Teacher's actions.

5D. Group work and student discussion dominated all class sessions. Students conducted an inquiry-lab for two days. During the third class session, students taught their peers as fungi experts regarding specific fungi types. 6C. Hands-on activities were conceptually focused and one correct answer during identification was sought for each fungi example. 7C. Teacher-student interaction concerned the correctness of student application of knowledge. Teacher did not reveal quick answers to students. 8D. Teacher's questions were goal orientated and were in response to students' responses. Teacher asked students to *use mind instead of book*. 9C. Teacher actively engaged in monitoring class sessions by asking probing questions concerning student's scientific process. 10C. Teacher checked student's knowledge by question and answer throughout class sessions. 11C. Teacher listened to students' ideas and allowed students to accept their own ideas until their own observations and thinking challenged them.

Student's actions.

12C. Several forms of writing were utilized as students drew representations of fungi, wrote their own constructed hypothesis, and wrote fungi facts from book and fellow classmates. 13C. Student questions clarified concepts or procedures. Several students asked if they could draw or write things down on paper and how they use microscope correctly. Some student questions concerned definitions of the fungi characteristics. 14D. Student-student interaction predominantly discussed fungi traits and characteristics in attempt to label the fungi. Typical student conversation was as follows: Student 1 – *For number 5, we put sacs*. Student 2 – *But it is sporangium*.

Student 3 – *but it was soft brown spots dividing into sections*. One student asked another student *what are these swirl things*? 15D. Students regularly volunteered analysis of fungi during observations. Several students claimed fungi appeared like *bacon, cheese, ham, and bread with mold*. 16D. Students struggled with identifying fungi. Students asked teacher frequently for answers and teacher responded by suggesting they might want to *view [the samples] again and re-assess*. Students appeared surprised that they could view the samples again.

Resources.

17D. Teacher resources included prepared fungi samples, grown fungi samples, teacher-constructed lab worksheet, three-powered objective microscopes, and dissecting scopes. 18D. Students utilized resources in drawing, viewing, and investigating materials. 19D. Students moved around room freely accessing any resource within the classroom. Students appeared to view classroom as communal property. Teacher permission was not required to retrieve materials. Students freely retrieved materials independently on a needed basis.

Environment.

20C. Teacher asked students by the show of hands *who had completed all Day 1's objectives*? After only four student's hands were raised, teacher stated that they would complete drawings next class session. 21C. Teaching aids included many posters and a single aquarium. 22D. Student's work was displayed on walls as posters and on shelves as projects. Student class pictures were on wall.

As shown in Table 18 (p. 108), *STAM* subcategories 1-4 code for content; subcategories 5-11 code for teacher's actions; subcategories 12-16 code for student's actions; subcategories 17-19 code for resources; and subcategories 20-22 code for environment. A simple numerical average was calculated from the *STAM* data for each participant's content, teacher's actions, student's actions, resources, and environment. The identical ordinal scale assigned to each style in the *TPPI* average was employed with the *STAM* average; for example, didactic remained (1). Each participant's *STAM* averaged value for content, teacher's actions, student's actions, resources, and environment is provided in Table 27. Table 27 data are presented graphically in Figure 4, thereby creating a graphic profile for each subject.

TPPI & *STAM* Comparison Data for Teacher Action, Student Action, and Years Experience

As shown in Table 18 (p. 108), seven *STAM* subcategories (5-11) code for teacher's actions; while, five *STAM* subcategories (12-16) code for student's actions. Selected *TPPI* questions produced results for teacher actions (TA) and student actions (SA) as well. Both the *TPPI* and *STAM* instruments code for teacher and student's actions along the continuum of didactic to inquiry style. To compare the *STAM* and *TPPI* data in the teacher and student action subcategories, *STAM* and *TPPI* averages were compiled. *STAM* data values from Table 27 and *TPPI* data values from Table 16 of

Table 27

Participant *STAM* Codes Where 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5 = Experienced Constructivist, and 6=Inquiry Constructivist

Teacher Number	Teacher Name*	*STAM* Content	*STAM* Teacher Action	*STAM* Student Action	*STAM* Resources	*STAM* Environment
T1	Richard	2/3	2/3**	2	3/4	1/2
T2	Susan	1/2	3/4	2	3	2/3
T3	Tanya	2/3	3/4	2/3	3/4	1/2
T4	Nancy	2	3/4	2/3	4	3/4
T5	Nathan	1	1/2	2	1/2	2/3
T6	Delaine	2/3	2/3	3	3/4	4
T7	Lucy	NA	1/2	2/3	3/4	1/2
T8	Eileen	3/4	3/4	3/4	4	3/4

Note. *Pseudonyms replace actual teacher's names. **Values written with slash indicate participant score wobbles within range of listed numbers.

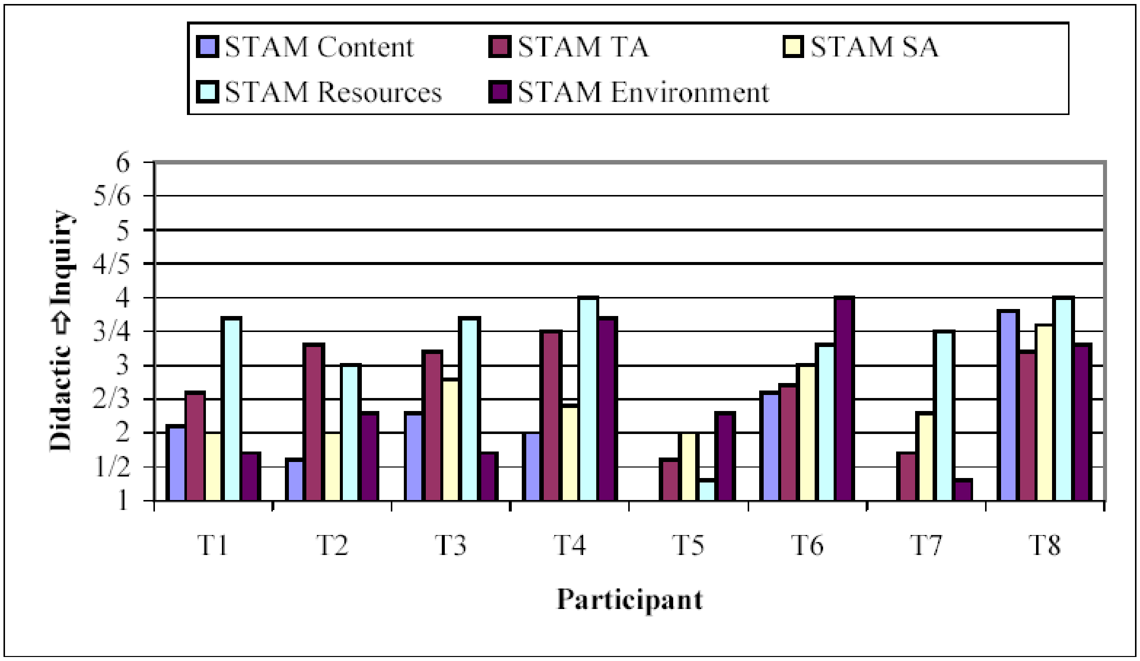

Figure 4. *STAM* data representation for each participant's content, teacher's actions (TA), student's actions (SA), resource, and environment.

teacher's actions and student's actions were provided in Table 28 for comparison. The *TPPI* and *STAM* comparison Tables 28 (Ordinal Data from *TPPI* and *STAM* Codes) and 29 (*TPPI* and *STAM* Teacher and Student Action Data Combined by Cohort**)**, in conjunction with Figures 5 (Participant *TPPI* and *STAM* comparison data for teacher's actions), and 6 (Participant *TPPI* and *STAM* comparison data for student's actions) provide data to answer Research Question 4.

Research Question 4: Are teacher's actions consistent with their philosophy? Are there measurable differences in the presence and quality of inquiry instruction among the three cohorts within the classroom?

Table 28 data are presented graphically in Figure 5, thereby creating a graphic profile for each subject for teacher's actions (TA). Table 28 data are presented graphically in Figure 6, thereby creating a graphic profile for each subject for student's actions (SA).

The eight participants were selected from three separate cohorts, which are defined in Table 4 (see Chapter III, p. 60). The three cohorts had varying numbers of years teaching experience: Cohort IV had zero years teaching experience; Cohort II had two years teaching experience; and Cohort I had three years teaching experience. Cohort IV consisted of T1, T2, and T3 participants; Cohort II consisted of T4, T5, and T6 participants; and Cohort I consisted of T7 and T8 participants. The *TPPI* and *STAM* TA and SA scores were combined to provide data for the three Cohorts. The Cohort combined data for *TPPI* and *STAM* TA and SA are provided in Table 29.

Table 28

Ordinal Data from *TPPI* and *STAM* Codes for Teacher and Student Actions

Teacher Name***	Teacher Number	TPPI TA*	TPPI SA**	STAM TA	STAM SA
Richard	T1	3/4****	2/3	2/3	2
Susan	T2	2/3	2/3	3/4	2
Tanya	T3	2/3	2/3	3/4	2/3
Nancy	T4	2/3	2/3	3/4	2/3
Nathan	T5	1/2	1/2	1/2	2
Delaine	T6	2/3	2/3	2/3	3
Lucy	T7	2	2	1/2	2/3
Eileen	T8	2/3	3	3/4	3/4

Note. *TA denotes teacher's actions. **SA denotes student's actions. ***Pseudonyms replace actual teacher's names. ****Values written with slash indicate participant score wobbles within range of listed numbers.

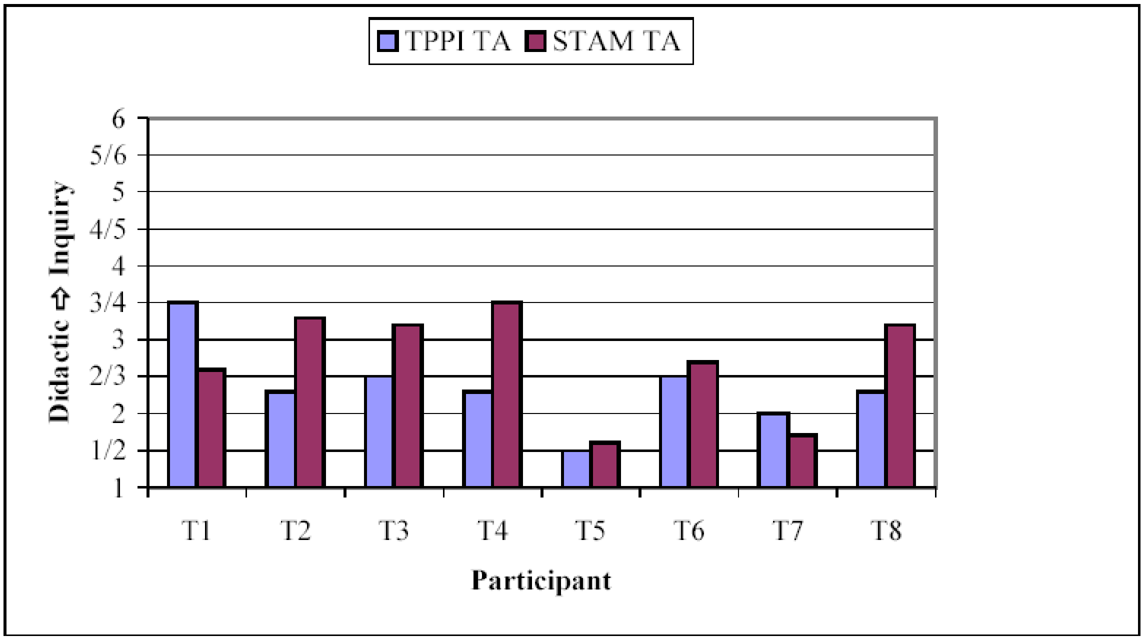

Figure 5. Participant *TPPI* and *STAM* comparison data for teacher's actions.

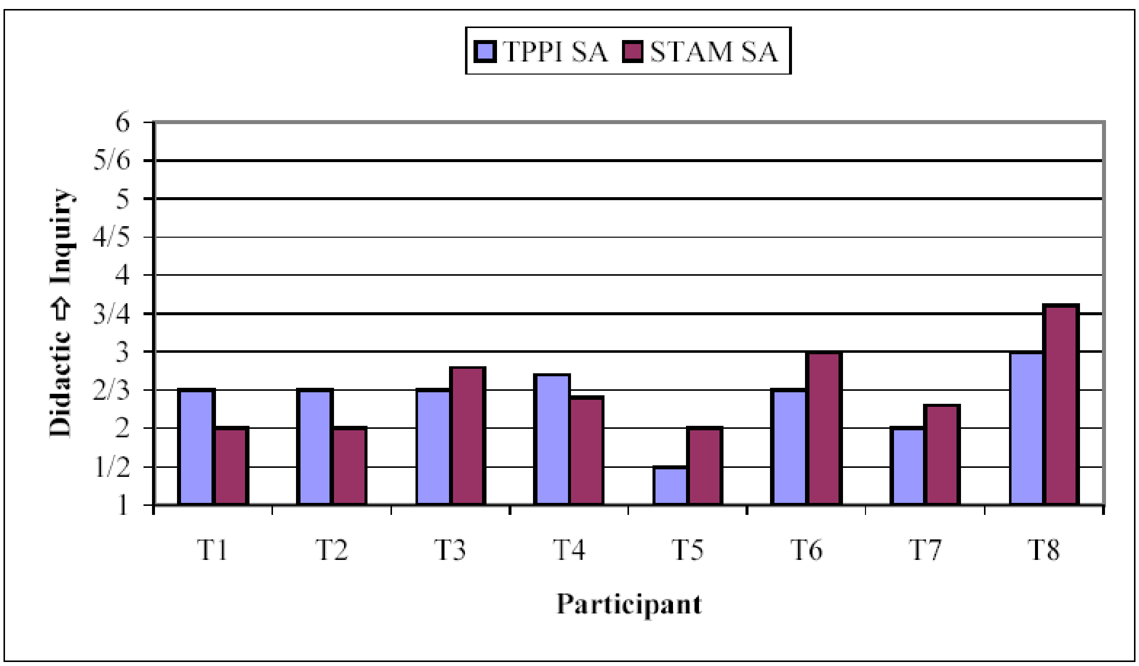

Figure 6. Participant *TPPI* and *STAM* comparison data for student's actions.

Table 29

***TPPI* and *STAM* Teacher and Student Action Data Combined by Cohort**

Cohort Number	Years Teaching	*TPPI* Teacher Action	*STAM* Teacher Action	*TPPI* Student Action	*STAM* Student Action
IV	0	2/3*	3	2/3	2/3
II	2	2/3	2/3	2/3	2/3
I	3	2/3	2/3	2/3	3

Note. *Values written with slash indicate scores wobble within range of listed numbers.

Findings

1. From the *TPPI* interviews, the following teaching styles were professed for combined teacher action (TA) and student action (SA):

- 62.5% wobbled between transitional and conceptual
- 12.5% coded didactic
- 12.5% wobbled between didactic and transitional
- 6.25% coded conceptual
- 6.25% wobbled between conceptual and early constructivist

2. From the *TPPI* interviews, all participants selected the *Knowing and Teaching Science: Just Do It!* course in response to questions concerning beneficial coursework. The course was selected five times as a beneficial educational course making it the greatest selected educational course. Additionally, the course was selected three times as a beneficial science course.

3. From the *TPPI* interviews, two participants selected the educational course *Professional Studies – The Learner*. The course was selected once as beneficial and once as unbeneficial. The remaining educational coursework listed in Table 17 (disregarding the *Knowing and Teaching Science: Just Do It* course) was selected only once.

4. From the *TPPI* interviews, five of the eight participants (62.5%) did not list a single science course that was unbeneficial when they began their teaching. One of the eight participants (12.5%) stated that all science courses were beneficial. Three of the eight participants (37.5%) selected *General Biology* and three selected *Botany 531 Knowing and Teaching Science: Just Do It!* as beneficial courses. Three of the eight participants chose *Physics*; however, two listed the course as beneficial, while one listed the course as unbeneficial. Two participants selected *Organic Chemistry*; one selected it as beneficial, while one selected it as unbeneficial.

5. From the *STAM* observations, the following teaching styles were professed for content, teacher action (TA), and student action (SA), resources, and environment:

- 31% wobbled between conceptual and early constructivist
- 26% wobbled between transitional and conceptual
- 18% wobbled between didactic and transitional
- 10% coded transitional
- 8% coded early constructivist

- 5% coded conceptual
- 2% coded didactic

6. In comparing teacher's philosophical beliefs to observable action for SA and TA, 50% of the participants professed a teaching style lower on the *STAM* scale than their actual observed style. The remaining 50% was distributed as follows: 25% of the participants professed a teaching style higher than their actual observed style, while 25% of the participants professed a teaching style consistent with their actual observed style.
7. As the entire cohort's teaching experience in the classroom increased in years, 83% of the participants' beliefs and actions remained wobbling within the transitional to conceptual range.

CHAPTER V

CONCLUSIONS, DISCUSSION, AND IMPLICATIONS

Organization of the Chapter

This Chapter presents the purpose of the study and summary discussions of the findings. The chapter is organized into four sections:

(1) Summary of Study
(2) Conclusions
(3) Discussion
(4) Recommendations

Summary of Study

Purpose of the Study

The purpose of this study was to provide both a qualitative and quantitative analysis of science teacher's inquiry philosophy and action after completing the University of Tennessee course, *Knowing and Teaching Science: Just Do It.* Understanding transferable knowledge and outcomes from the inquiry-based method to teacher's actual practice and philosophy is vital feedback for the course designer and instructor. This study provides linkages between teacher philosophy and action after an inquiry-based research course experience.

The researcher posed the following four questions for this study:

1. What are the philosophical tenets of beginning teachers with regard to inquiry instruction?
2. How have these same teachers' practices and beliefs been influenced by the University of Tennessee science teacher preparation program?
3. What are the teachers' observable practices in the classroom? How do these teachers' classroom practices align with inquiry instruction?
4. Are teacher's actions consistent with their philosophy? Are there measurable differences in the presence and quality of inquiry instruction among the three different cohorts within the classroom?

Review of Methodology

As outlined in Chapter 2, this study utilized a mixed methodological research method of eight participants who had previously completed an inquiry-based science teacher preparation course in Botany. Three instruments from the Salish I research project were used to gather participant data; the three instruments included the *SIDESTEP* (see Appendix B)*, TPPI* (see Appendix C) and the *STAM* (see Appendix D). The *SIDESTEP* provided demographic information of each participant. Fourteen *TPPI* questions provided interview data concerning participants' beliefs regarding teacher's actions, student's actions, and teacher philosophy. The *STAM* observational rubric provided data regarding content, teacher's actions, student's actions, resources, and environment.

This study relied chiefly on interview and observational data. The researcher transcribed and coded interview data using the *TPPI* instrument concept maps and Supercoding matrix. The researcher and assistant were introduced to the *STAM* instrument during a graduate science educational course. They then co-trained each other to use the *STAM* observational rubric. After viewing three hours of each participant's class sessions, both the researcher and assistant coded the observational data independently. This study reported the researcher's *STAM* results only. The assistant's *STAM* data were used to calculate an inter-rater reliability percentage between the researcher and assistant's *STAM* scores for each participant.

Conclusions

Following the Salish I study protocol (Simmons et al., 1999), the interview and observational data codes were collapsed into broader descriptors. The teaching-centered domain included didactic and transitional styles; conceptual-centered domain included the conceptual style; while, student-centered domain included the early and experienced constructivist styles (see Table 30).

In responding to Research Question 1, the philosophical tenets of beginning teachers with regard to inquiry were predominantly teacher-centered beliefs. The most frequently professed teaching style according to the *TPPI* concerning student and teacher

Table 30

Percentages of Teaching Styles of Coded Interview and Observational Participant Data (n=8)

Collapsed Teaching Style	Teaching Style	TPPI Codes*	STAM Codes*
	Didactic	12.5	2
TEACHER-CENTERED	Wobble between Didactic and Transitional	12.5	18
	Transitional	0	10
	Wobble Transitional to Conceptual	62.5	26
		87.5**	**56**
CONCEPTUAL	Conceptual	6.25	5
	Wobble between Conceptual and Early Constructivist	6.25	31
		12.5	**36**
STUDENT-CENTERED	Early Constructivist	0	8
	Experienced Constructivist	**0**	**8**

Note. *Values are reported as percentages. **Bolded values are summations of column percentages for teacher-centered, conceptual, and student-centered styles.

action was the teacher-centered style, at 87.5% (see Table 30 bolded values). Therefore, the 87.5 percentage included participants' items that coded didactic and transitional, as well as, those items that wobbled between didactic and transitional and between transitional and conceptual. The remaining 12.5% of responses coded for the conceptual teaching style. The conceptual code is situated on the *STAM* rubric between the teacher-centered styles (didactic & transitional) and the student-centered styles (early constructivist, experienced constructivist, & constructivist inquiry). Hence, the conceptual style represents a blending of teacher-centered and student-centered approaches.

In responding to Research Question 2 concerning influential coursework offered during the University of Tennessee, 100% of the participants selected the *Knowing and Teaching Science: Just Do It* course as beneficial. Participants classified the course as both a College of Liberal Arts science course and as a College of Education teacher preparation course. Five of eight (62.5%) participants did not select a science course that was not beneficial when they began teaching.

In responding to Research Question 3, participants' observable classroom practice resulted in greater than half of participants (56%) having an observed teaching style within the teacher-centered domains with regard to content, teacher's actions, student's actions, resources, and environment (see Table 30 bolded values). Again, the teacher-centered domains encompassed the didactic and transitional styles. Included within the 56% of participants' scores are the didactic and transitional styles, as well as, those styles that wobbled between didactic and transitional and between transitional and conceptual.

Greater than one third of the participants (36%) scored within the conceptual range by either coding for conceptual style or wobbling between conceptual and early constructivist. The remaining 8% of the participants scored within the student-centered range by coding for the early constructivist style.

In responding to Research Question 4, each participant's professed *TPPI* data was compared to his/her observed *STAM* data. The resulting data displayed that 50% of the participants expressed teaching style characteristics more teacher-centered than their actual observed style. Restating from another perspective, 50% of the participants were more student-centered with regard to their practice than their professed style. The remaining 50% were divided evenly. Those participants either decreased or remained consistent from their professed to their observed style. Among all of the participants, 83% of the cohort's interview and observational codes remained within the transitional range.

Discussion of the Results

The participants displayed in their practice and professed in their interview predominantly teacher-centered transitional and conceptual teaching styles. Increased years of teaching experience among the cohort groups did not present noticeable or marked decreases or increases within the teaching style. Actually among the three cohorts, 83% of all the participants' interview and observational scores remained within the teacher-centered transitional teaching style.

By investigating the teacher's *STAM* data individually, Nathan (T4) remained within the teacher-centered range of didactic to transitional for all *STAM* categories. Delaine (T6) and Eileen (T8) displayed student's actions, resources, and environment within conceptual and student-centered domains. Nancy (T4) displayed student's actions, resources, and environment within the student-centered domains. Susan (T2), Richard (T1), Lucy (T7), and Tanya (T3) wobbled from teacher-centered to conceptual to student-centered domains within various *STAM* categories.

Overall, Nathan (T5) does not appear to be moving towards a conceptual inquiry style of teaching. Susan (T2), Nancy (T4) Richard (T1), Lucy (T7), and Tanya (T3) do not appear stable in any certain *STAM* major category, as they wobble from teacher-centered to conceptual to student-centered. Delaine (T6) and Eileen (T8) maintained values in the conceptual to student-centered domain that were greater than the preceding teachers. Eileen (T8) exhibited the most student-centered observed behavior. In fact, all of Eileen's (T8) *STAM* codes were within the conceptual to student-centered styles.

In reference to teaching experience, Eileen (T8) from Cohort I had three years of classroom experience and the greatest number of student-centered codes. However, Lucy (T7), also from Cohort I with three years teaching experience, did not exhibit the same type of teaching style. Susan (T2), Richard (T1), and Tanya (T3) were in the process of completing their first year of teaching as an intern. All three interns expressed great appreciation in that they were allowed to borrow and use their mentoring teacher's classroom and lesson materials. The researcher was not able to distinguish the intern's lesson plans and classroom environment from the mentoring teacher's; therefore, an assumption was made that the intern's lessons and classroom environment were combined efforts from the mentor and intern.

Investigating the participant's *TPPI* interview data revealed that Richard (T1) and Eileen (T8) were the only participants with responses in the conceptual style domain. The remaining participants expressed beliefs within the teacher-centered range. All participants (excluding T1 & T7) professed the teacher's action item lower on the inquiry continuum than their observed *STAM* coded practice. All participants (excluding T1, T2, & T4) professed the student's action item lower on the inquiry continuum than the observed *STAM* coded practice.

Both researcher and assistant deemed Lucy's (T7) *STAM* content data uncodable. Immediately after Lucy's classroom observations, the research and assistant stated that the content scoring for the lessons was going to be difficult, if not impossible. The researcher and assistant collaborated and determined that the final *STAM* report would code Lucy's content *STAM* items as not applicable (NA). Lucy's remaining eighteen subcategories were scored utilizing the *STAM* rubric; however, content (1-4) items were reported as NA.

The investigation for the NA coded items included both of Lucy's observable lessons. The researcher and assistant observed students enthusiastically engaged in an activity involving a ball bearing and aquarium tubing. During both of the 90-minute class sessions, the students were engaged in the construction of a *roller coaster* with the teacher-provided materials. Lucy requested that the students design a *roller coaster* upon which the ball bearing would stop within one inch of the tubing end. While monitoring the student activity, Lucy asked the students questions such as "how are you guys doing there?" During the observed classroom sessions, Lucy did not make connections between the activity and physical science concepts. According to Lucy, the students had prior knowledge of the following physical science concepts: velocity, acceleration, centripetal force, gravity, and friction. The researcher and assistant observed two consecutive days of an activity that was not verbally related to any physical science content by either the teacher or students. At the end of second day, all groups demonstrated their roller coaster design in front of the class to reveal if the ball bearing would stop at the teacher's allotted line. Lucy had assigned a one-page written report asking the students to detail physical science terminology to their *roller coasters*; however, physical science knowledge/content was not observed during either of the 90-minute class sessions.

Prior Research

This study extended the results of the Salish I Research Collaborative (1997) and Salish II (Robinson & Yager, 1998) collaborative by reporting teachers' beliefs and practices. This study used parts of the Salish I *TPPI* (Richardson & Simmons, 1994) instrument for interview data and the entire Salish I *STAM* (Gallagher & Parker, 1995) instrument for observational data. The study also employed and adopted the Salish I *SIDESTEP* (McGlamery, 1993) instrument for demographic data.

The Salish I study reported that first-year teachers were mostly teacher-centered in their actions (Simmons et al., 1999). However, even after three years of teaching experience, no single teacher coded within the predominantly student-centered styles. First-year teachers described themselves as student-centered during their interview; although, their actions revealed teacher-centered styles. Simmons et al. discovered that teacher's actions and beliefs became more congruent as they increased in years of teaching experience; however, these congruent actions and beliefs were still reported within the teacher-centered styles.

As Salish II participants, Melear, Hickok, Goodlaxson, and Warne (1998) reported beginning research on the *Knowing and Teaching Science: Just Do It* course by presenting student journal responses from the first cohort, Cohort I. Melear, Goodlaxson, Warne, & Hickok (1999) provided additional results of critical incidents from Cohort I by evaluating student journals, instructor's post-class discussions, and student's remarks. Simmons et al. (1999) presented the Salish I final results and solicited further research in determining the congruence or incongruence between beginning teacher's belief systems and their classroom actions. Subsequent to the Simmon's et al. charge for further research, a few studies have reported on teacher's beliefs, teacher's actions, and the relation of beliefs to action (McGlamery & Fluckiger, 2001; Adams & Krockover, 1999; Waggett, 1999).

Unexpected Finding

From results of the Salish I study, Simmons et al. (1999) stated in Assertion 13 that "beginning teachers described their practice as very student centered" (p. 947). Of the 69 participants in the study, Simmons et al. found that the "observed teaching practice contrasted starkly with teacher beliefs . . . . While teacher[s] professed student-centered beliefs, they behaved in teacher-centered ways" (p. 947). Waggett's (1997) research reported a similar finding among 42 participants. Wagget gathered data on teachers' beliefs and practices by utilizing the *TPPI* and the *ESTEEM* observational instrument and reported that the "stated [teacher] beliefs do not necessarily manifest into desired practice" (p. 46).

This study's unexpected finding includes the following: All participants, with the exception of Richard (T4) and Lucy (T5), expressed teacher's actions more teacher-centered during the interview than what was observed during their classroom practice. All participants, with the exception of Susan (T2), Nancy (T3), and Richard (T4), expressed student's actions more teacher-centered during the interview than what was observed during their classroom practice. According to the results of the Salish I report (1997) and Waggett's (1997) study, one would have expected to find incongruity between the interview responses and the observed behavior. From their studies, one would have predicted that the participant's observed behavior would be more teacher-centered, while, the participant's interview responses would be more student-centered. My study's results were contradictory to Simmons et al. (1999) and Waggett's findings. Most of the participants in this study scored either higher or remained consistent on the inquiry continuum with regard to their professed beliefs and their observed practice. Consequently, this study reports more congruity between what the participants believed and what they practiced.

Implications for Practice

Disregarding the discrepancy in participant number from the Salish (1997) study, this study's participants professed their philosophy of student and teacher actions lower on the inquiry continuum than their actual teaching practice. One attributing factor for the participant's modest or reserved inquiry views could be attributable to the completion of UT authentic inquiry-based coursework.

During my two-semester involvement as a teaching assistant with the *Knowing and Teaching Science: Just Do It* course, my observations included apparent struggles among the newly graduated science majors. Course participants' revealed in the interview that they were hesitant to voice opinions or ideas aloud in cooperative groups for fear of appearing *dumb* or *stupid*. Most of these students already had obtained an undergraduate degree in a scientific subject area; therefore, they felt they were expected to possess capabilities in designing an experiment.

Even with the possession of a biology degree or advanced scientific background, most of the *Knowing and Teaching Science: Just Do It* students began their first experimentation in the class using a sample size of one (n=1). Also, most participants began their experiments by testing one variable per individual sample. Controls and duplicates were not part of the student's scientific lexicon. After completing authentic inquiry-based coursework, the participants were able to define authentic inquiry from the student's perspective. By participating in this course and other courses at UT (see Table

3), these students have actually completed the trials and tribulations in designing and reporting experimental results.

During the course, the students slowly realized that the answers were not given to them directly; therefore, they were forced to learn from each other. They had to ask the questions, design the experiments, analyze the results, and then present the conclusions. The term *forced* was selected due to a previous course participant referring to the course as providing opportunities for *forced inquiry* (see pg. 106). By forging through the awkward and uncomfortable feelings of the experimental unknown, the *Knowing and Teaching Science: Just Do It* participants experienced an authentic inquiry environment. Hence, the participants' responses to the *TPPI* questions regarding teacher and student behaviors were framed within the participant's definition and experience of inquiry methodology. The participant's definition of inquiry was derived from the following models: Dr. Hickok's model in the *Knowing and Teaching Science: Just Do It* course, the additional UT teacher preparation courses (see Table 3), and from the secondary school setting.

Although a single study of one teacher preparation program cannot provide a sound basis for implementation nationally, this study strongly supports the implementation of a research–based model course for preservice teachers. From the participants' unsolicited remarks of their experience during *Just Do It* course (see pages 105-106), one can surmise the value of being a student participant involved with the inquiry approach. Hemler (1997) supported the Green Bank Program NRAO research experience "to help any traditional conceptions about science" (p. 177). Brown and

Melear's (2002) study supported and revealed such traditional conceptions, as the participant stated that she "couldn't do research in public schools [or specifically] do research with [a] 10th grade class. It's just not done, as far as scientific research" (p.23). The research experience may not be replicable entirely within the secondary school setting; however, it does provide an opportunity for undergraduate science majors to experience research and confront misconceptions about scientific processes. The authentic inquiry experiences were often an entirely new experience for the participants.

Supportive statements for the use of a research-based course originate directly from the teacher's remarks in this study. From responses to this study and from Suters, Melear and Hickok's (2002) prior study, a reported conclusion is that teachers value the research course experience. Reported skills they value are: asking questions, designing experiments, analyzing results, and writing research papers. Additionally, the course participants express an empathetic philosophy with regard to student's struggles in performing inquiry-based science. The preservice teachers express appreciation of the course climate in that it provides them the opportunity to experience similar frustrations to what their students will possibly encounter. The preservice teachers expressed empathy when their students displayed frustration when an immediate answer was not given and/or a predetermined experimental outline was not dictated. Therefore, the preservice research experience has value for the teachers in that they experience scientific inquiry in the same method that they would teach their future classes. Thereby making them empathetic with the difficulties of inquiry not previously reported in the literature.

This study supports Waggett's (1999) claim that the classroom environment of the cooperating teacher is important in supporting new teachers' efforts in implementing inquiry-based instruction. Hemler (1997) also noted that the cooperating/mentoring teacher was a large influencing factor on beginning teacher action. Often interning and beginning teachers espouse beliefs and perform actions reflecting the model implemented in their school. The interns and teachers collaborate and learn methods from interacting with each other; therefore, a strong influence on implementing inquiry-based instruction originates from within the school climate. This influence was observed mostly with the teachers who interned, as they borrowed their mentor's classroom and materials.

Waggett (1999) also reported that researchers should not rely on self-reported data alone. This study strongly supports that view by not only gathering participant-reported interview data, but also gathering outside-reported observational data. The single most effective method in gathering data concerning teacher behavior is to observe the teacher's actual practice. However, to substantiate and support the outside observer's finding as a member checking protocol, the participants themselves can videotape, observe, and analyze their own teaching. Providing training for teachers to perform video observations and then code their own practice could foreseeably accomplish multiple goals. The possible goals are to: 1) provide autonomy to the teacher as researchers of their own practice; 2) provide a heuristic device for guiding teacher's style development (Adams & Krockover, 1999); 3) support awareness and common understanding of inquiry-based methods; and 4) offer practical knowledge concerning performance-based assessments of teaching practice.

Recommendations

Additional research is warranted within school settings to determine a basis for the sparse representation of inquiry-based and student-centered instructional approaches observed in this study. Three recommendations arose from this study.

1) A different approach than this study implemented should be used to determine explicitly the type of inquiry methods teachers and students are capable of performing requires. During this study, the teachers were instructed to perform teaching methods that would be representative of any *normal* instructional day. A researcher may determine where the teacher's *best* practice would be situated along the continuum by asking the teachers to conduct their *best* inquiry practice. The inquiry style that teachers and students are capable of conducting may or may not be determined to be different than determining what they are currently conducting in their classroom routinely. The three-hour observation used in this study may or may not be long enough to indicate what occurs during classroom instruction on a typical day. The three-hour observation may or may not be indicative of what the teacher and students can actually do.
2) Investigate and determine barriers (s) in implementing inquiry-based models within the school setting by increasing the observation numbers of fewer teachers. For example, use a case study model of one or two teachers. Interviewing and observing fewer teachers over an extended time period provides a richer source of data that is grounded within the context of those particular teachers. The existing

literature regarding inquiry constraints consists primarily of teacher self-reported perceived impediments. When additional data is provided confirming actual observed constraints, teacher preparation programs can improve with methods to address these issues. These methods can assist teachers in lessening or alleviating these barriers. Multiple university case studies may be compiled as a meta-study to provide a national perspective in dealing with inquiry barrier constraints.

3) Follow the same participant sample through their first five years of teaching experience to provide a longitudinal study that can determine the change(s) in teachers' beliefs and behavior with increased years of teaching experience. These beliefs and actions may or may not change as teaching experience increases. By soliciting the participant to act as co-researcher to conduct the same method of analysis of their own instruction, the researcher further validates the observed data. By continuing the research and training of the teachers after graduation, researchers can solicit inservice teachers to reflect on teaching beliefs and actions that were encouraged by the university preparation program.

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APPENDICES

Appendix A

Participant and High School Principal Sample Consent Letters

Informed Consent Form for Members of the 2001 and 2002 Research Experience for Preservice Teachers (REPT) Cohorts

You are invited to participate in a research study. The purpose of this study is to assess the effects of courses specifically designed to teach inquiry-based science to a group of preservice science teachers and to determine individual teaching styles based upon a continuum from didactic to constructivist inquiry. This project originated as a pilot study of the Salish II research consortium designed to research and implement programs that adequately prepare science teachers for the new standards of teaching, which require student-centered inquiry as the basis of instruction. The Salish II consortium currently consists of university/college faculty in the sciences, science education and cognitive sciences from over 46 institutions in 24 states. The Consortium focuses on the preparation of science teachers as defined by the emerging U.S. National Education Standards and Assessment.

Your participation in this study may include the following:

1. Completing the Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP). This written survey will take approximately 10 minutes
2. Being audio-taped during an interview utilizing the *Teacher Pedagogical Philosophy Interview* (TPPI). The interview will be recorded on audiotape and then transcribed by researcher. The interviews will occur at the secondary school site during planning period or before/after school. This assessment is an oral interview lasting approximately 30 minutes
3. Making a concept map of Unit Content, answering six questions concerning lesson for five days in journal as part of Video Portfolio. This written portion will take approximately 60 minutes total to complete.
4. Being video- and audio-taped for three consecutive classroom lessons.
5. Providing the last four digits of your social security number for use in coding the data.

Risk of Participation

If you decide to take part in this study, the risk of being identified on videotape is possible. Segments of the videotaping will be used in formal scientific presentations such as the National Science Teachers Association (NSTA), National Association for Research in Science Teaching (NARST), and other science education conferences. The use of these segments will be to illustrate the innovative approach to teaching inquiry science within the courses. Every possible effort will be taken to minimize recognition of the participants. This includes the use of pseudonyms both in the transcription of the audio and videotapes and when referring audibly to the participants during videotaping.

Benefits

The benefits are the likelihood that this project will provide the knowledge and the experience necessary to teach science by inquiry, in ways previously not attained in any other science teacher preparation program. National Science Education Standards recommend that science teachers use the inquiry student-centered strategy (rather than didactic strategies) to teach in the middle to high school.

Confidentiality

The information in the study records will remain confidential. All data will be stored securely and will only be made available to persons conducting the study unless you specifically give permission in writing to do otherwise. No direct reference will be made in oral or 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 principal researcher, Sherri L. Brown, by phone number (865) 588-1440. If you have questions about your rights as a participant, you may 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 your request.

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

Participant's Signature ______________________________ Date _____________

Investigator's Signature ______________________________ Date _____________

Last 4 digits of your social security number ______________

Month Day, Year

Sherri L. Brown
Address
Knoxville, TN 37909

(Name) High or Middle School
Attn: Principal's Name
School Address
Knoxville, TN (Zip Code)

Principal's Name,

I am currently a doctoral candidate at the University of Tennessee-Knoxville in the Theory and Practice Teacher Education Department. I am writing to request permission to conduct teacher education research at (Name) High/Middle School. Enclosed is a copy of the Knox County Research Request Form and the Knox County consent letter signed by Dr. Mike Winstead, Knox County Coordinator of Research and Evaluation.

The research study will involve no more than two science interns at your school. Upon consent, intern participation in the study includes:

1. Being interviewed and audiotaped about teaching philosophy
2. Providing a concept map of a one-week subject Unit
3. Being videotaped 2 times during the teaching of that Unit.
4. Answer 6 questions at the end of each lesson during the one-week Unit.
5. Providing the last four digits of social security number for use in coding data.

The research study total time per teacher participation is estimated to be approximately 2 hours. If you have any questions at any time about the study or the procedures, please contact the researcher at (865) 588-1440 or sbrown20@utk.edu.

Thank you for your continued support in promoting teacher research,

Sherri L. Brown

I have read the above information and agree to participate in this study. I have received a copy of this form.
Signature ___________________ Date ___________________
(Name) High School

Appendix B

Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP) and Standard Operating Procedure

Salish I Research Project
SIDESTEP
Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs

Standard Operating Procedures

SIDESTEP consists of three parts. Part I is designed to gather information about the preservice experiences of the teacher. Part II is designed to gather information about the current teaching situation of the teacher. Part III is designed to gather information about the social and economic setting of the school.

SIDESTEP - Part I

This part, which will take approximately 10-15 minutes to complete, should be administered as near to the beginning of the school year as possible. It should be given to all first year teachers and to any second or third year teachers who have not yet completed it.

Part I can be administered by itself, or in conjunction with Parts II and III. Each site will need to decide what would be best given the current situation and relationships with the teachers. The instrument can be sent out via mail; the researcher does not need to be on site.

SIDESTEP - Part II

This instrument should be administered near the beginning of each year to each participant. The instrument will take approximately 30 minutes to complete.

Part II can be administered by itself, or in conjunction with Part III. Each site will need to decide what would be best given the current situation and relationships with the teachers. The instrument can be sent out via mail; the researcher does not need to be on site.

SIDESTEP - Part III

This instrument can be administered any time during the school year. It only needs to be administered once per teacher per school. Note, however, that should the teacher change schools, Part III will need to be administered again to reflect the new teaching situation.

Each site will need to decide the best method and data source to complete Part III. This could be through state data, NCISE data, or calling the school administration. The new teacher is NOT a good source to complete this part.

SUMMARIZING SIDESTEP DATA

The Salish I study developed and used the coding scheme following the SIDESTEP for preparing these data for analysis. These codes were entered into an Excel spreadsheet for each teacher for later cross-site analysis. Users of this instrument may want to develop their own scheme that makes sense to them in light of available software and their plans for statistical analysis of these data.

Subsequent to being entered into a spreadsheet, SIDESTEP data for each teacher-year is decoded in the form of a written summary for entry into the Teacher Data Matrix that is included with this package. The table entitled Components of the Teacher Data Matrix shows the part of the SIDESTEP needed to write this summary. An example of such a summary follows the SIDESTEP instrument.

Salish I Research Project
SIDESTEP - Part I
Salish Inventory for Demographic Evaluation
of Schools and Teacher Education Programs

Welcome to SALISH! As a way of finding out a few things about your teaching situation, we would like you to complete this form. Thank you for your assistance!

Background Information: To be completed at the end of the student teaching experience.

Name: ______________________________ Phone: ____________________

Current Address: ____

____

1. Please indicate your: Age ________ Gender (circle one) Male (1) Female (2)
   Ethnicity (circle one): Asian/Pacific Islander (1) African-American (2) Hispanic/Latino (3)
   White, Not Hispanic (4) Native American/Alaskan Native (5)
   Other, Please Specify (6): ______________

2. Please indicate your academic major, minor, and areas of teaching certification:
   Undergraduate Major: ____________________________________
   Undergraduate Minor: ____________________________________
   Graduate Major: ____________________________________
   Area(s) of teaching certification: ____________________________________

3. Approximately how many hours of on-site school experience in high school, middle school/junior high, and elementary school did you participate in BEFORE you began student teaching? Check the appropriate number of hours below.

	High School (.1)	Middle School/ Junior High (.2)	Elementary (.3)
none (0)	______	______	______
10 to 20 hours (10)	______	______	______
21 to 40 hours (21)	______	______	______
41 to 60 hours (41)	______	______	______
61 to 80 hours (61)	______	______	______
81 to 100 hours (81)	______	______	______
101 or more hours(101)	______	______	______

4. Please check the extra-curricular activities you were involved with during your undergraduate program. (i.e., organizations, athletics, clubs)

   ______ Social Sorority or Fraternity (1)
   ______ Intramural (2)
   ______ Academic Sorority or Fraternity (3)
   ______ Student Council (4)
   ______ Varsity Athletics (5)
   ______ Science or Mathematics Organization (6)

4. Continued

______ Education Organization (7)
______ Residence Council (8)
______ Department Council, Committee or Organization (9)
______ Church Groups (11)
______ ROTC (12)
______ Community Volunteer (13)
______ Other (10): ______________________________

5. a. For how many weeks did you student teach? ______________

b. Did you student teach ______ full days? (1)
______ half days? (2)
______ less than half days? (3)

6. Referring to your student teaching assignment, indicate the number of sections taught in each of the areas below.

Grade Level - Middle or Junior High School (6-9)

No. of Sections	Subjects Taught	No. of Sections	Subjects Taught
______	6th Grade Mathematics (1)	______	Earth Science (6)
______	7th Grade Mathematics (2)	______	Life Science (7)
______	8th Grade Mathematics (3)	______	Physical Science (8)
______	Pre-Algebra (4)	______	6th Grade Science (10)
______	General Mathematics (5)		

Other, Please Specify (9): ______________________________

Grade Level - High School (9-12)

No. of Sections	Subjects Taught	No. of Sections	Subjects Taught
______	Geometry (1)	______	Biology (7)
______	Pre-Algebra (2)	______	Earth Science (8)
______	Algebra I (3)	______	Physical Science (9)
______	Algebra II (4)	______	Physics (10)
______	Trigonometry (5)	______	General Science (11)
______	General Mathematics/ Consumer Mathematics (6)	______	Chemistry (12)

Other, Please Specify (13): ______________________________

7a. Referring to your student teaching assignment, please report the gender and ethnic group of your cooperating teacher. If you had more than one cooperating teacher, please report the number in each category.

	MALE		**FEMALE**
______	African American (1)	______	African American (1)
______	Asian or Pacific Islander (2)	______	Asian or Pacific Islander (2)
______	Hispanic or Latino (3)	______	Hispanic or Latino (3)
______	Native American (4)	______	Native American (4)
______	White, Not Hispanic (5)	______	White, Not Hispanic (5)
______	Other, Please Specify: (6)	______	Other, Please Specify: (6)

______________________________ ______________________________

7b. Referring to your student teaching assignment, please report the grade level of your cooperating teacher. If you had more than one cooperating teacher, report the number at each level.

______ Middle School/Junior High ______ High School

Salish I Research Project
SIDESTEP - Part II
Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs

Background Information: To be completed by all teachers each year.

Date ________________________ Teacher Name ______________________________

School ______________________ School Phone ______________________________

1. Indicate the number of sections you are teaching this year in each of the areas below.

Grade Level - Middle or Junior High School (6-9)

No. of Sections	Subjects Taught	No. of Sections	Subjects Taught
______	6th Grade Mathematics (4)	______	Earth Science (1)
______	7th Grade Mathematics (5)	______	Life Science (2)
______	8th Grade Mathematics (6)	______	Physical Science (3)
______	Pre-Algebra (7)	______	General Science (10)
______	Algebra (8)	______	6th Grade Science (15)
______	General Mathematics (9)		
______	Geometry (11)		
______	Algebra II (12)		
______	Trigonometry (13)		

Other, Please Specify (14): ____

Grade Level - High School (9-12)

No. of Sections	Subjects Taught	No. of Sections	Subjects Taught
______	Geometry (7)	______	Biology (1)
______	Pre-Algebra (8)	______	Earth Science (2)
______	Algebra I (9)	______	Physical Science (3)
______	Algebra II (10)	______	Physics (4)
______	Trigonometry (11)	______	General Science (5)
______	General Mathematics/	______	Chemistry (6)
	Consumer Mathematics (12)	______	Anatomy/Physiology (14)
______	Integrated Mathematics (15)	______	Bio-technology (16)

Other, Please Specify (17): ____

2. What are your non-teaching assignments? Check all that apply.

______	None (0)	______	Club Sponsor (non-mathematics or science) (7)
______	Athletic Coach (1)	______	Study Hall (8)
______	Mathematics or Science Club Sponsor (2)	______	Detention (9)
______	Tutor (3)	______	Lunch Duty (10)
______	Faculty Committee (4)	______	Hall Duty (11)
______	Class Sponsor (5)	______	Bus Duty/Parking Lot Duty (13)
______	Department Chairperson or Team Leader (6)	______	Homeroom Supervisor (14)

Other, Please Specify (12): ______________________________

3. What specific strategies do you plan to use to address gender equity issues in your classes?

Refer to next sheet.

4. Do you currently have any students in your classes who are classified as having special needs?

______ NO ______ YES Please indicate the number _____

What specific strategies do you plan to use to address these special needs (if applicable)?

Refer to next sheet.

5. How many students do you have in your classes for whom English is a second language? __________ What specific strategies do you plan to use to address the needs of students with English as a second language (if applicable)?

Response Choices

Sidestep - Part II
Page 42.

Question 3

What specific strategies do you plan to use to address gender equity issues in your classes? Select all that apply.

a) present female scientists accomplishments along with male
b) include female scientist as visitors to class along with male
c) provide equal opportunity for females to work with science manipulatives/equipment along with male
d) vary roles of groups during experimental procedures
(For example: student who performs Secretarial/Recorder role in one group experiment has opportunity to perform Data Analysis role in another experiment)
e) Other: _______________________________________

Question 4

Do you currently have any students in your classes who are classified as having special needs?
What specific strategies do you plan to use to address these special needs (if applicable)?

a) student works with interpreter
b) individual counseling/tutoring
c) special considerations for testing (oral testing, allowance of misspelling, etc)
d) special considerations for homework and class assignments
e) pre-assess how each student best learns
f) pairing of same-need students
g) pairing of advanced with special need student
h) Other: _______________________________________

6. Please report the total number of males and females in your present classes by ethnic group:

	MALES		FEMALES
______	African American (1)	______	African American (1)
______	Asian or Pacific Islander (2)	______	Asian or Pacific Islander (2)
______	Hispanic or Latino (3)	______	Hispanic or Latino (3)
______	Native American (4)	______	Native American (4)
______	White, Not Hispanic (5)	______	White, Not Hispanic (5)
______	Other, Please Specify: (6)	______	Other, Please Specify: (6)

______________________________ ______________________________

7. In the past year, how many times have you attended a state, regional, or national science or mathematics teacher conference?

_____ None _____ One _____ Two _____ Three _____ Four or more times

8. In the past year, how many presentations at a state, regional, or national science or mathematics teacher conference have you made?

______ None _____ One _____ Two _____ Three _____ Four or more times

9. Please list your professional memberships (e.g., NCTM, NSTA, AAPT, state science or mathematics groups).

If you use computers and related electronic technologies, please complete question 10.

10. a) Do you have computers in your classroom? _____ NO _____ YES Please indicate how many. _____

b) Do you have access to a computer lab? _____ NO _____ YES Please indicate how often you use it. _________________________

What is the lab used for? Check all that apply.

______	Drill and practice (1)	______	Enrichment activities (4)
______	Word processing (2)	______	Other: (5) ________________
______	Projects (3)		________________________

c) Do you have access to (check all that apply):

Laser Disc layers (1) ______
CD-ROM (2) ______
Modem (3) ______

11. **If you use a textbook for the class involved in this study, please answer the following:**

Textbook Title: ______________________________

Edition: ______________________ Year Printed: __________

Supplementary Materials Used: (videos, laboratory workbooks, etc. __________

____

For First Year Salish Participants:

12. Does your school have a formal program to help beginning teachers?

_____ NO (0) _____ YES (1)

For Second or Third Year Salish Participants:

13. In the past year, how many presentations at local teacher conferences and/or in-service programs have you made?

_____ None _____ One _____ Two _____ Three _____ Four or more times

14. Please list by title any inservice(s), workshop(s), and or courses(s) that you have attended in the past year.

15. On the average, how many hours per week do you spend preparing to teach. Check the appropriate number.

_____ None (0) _____ 1-5 (1) _____ 6-10 (6) _____ 11-15 (11)
_____ 16-20 (16) _____ Over 20 (21)

16. Which of the following methods have you used to assess your students' understanding? Check all that apply.

_____	Group Work	_____	Multiple Choice Tests
_____	Worksheets	_____	True/False Tests
_____	Discussions With Students	_____	Fill-In-The-Blank Questions
_____	Standardized Tests	_____	Student Developed Protocols
_____	Essay/Short Answer	_____	Quizzes From the Curriculum
_____	Projects	_____	Lab Write-Ups
_____	Oral Reports	_____	Computer-Assisted Assessment
_____	Portfolios	_____	Other, Please Specify:
_____	Homework		______________________
_____	Concept Maps		______________________

17. List in order your top three goals for your students' learning:

Most important:

Second most important:

Third most important:

18. Estimate your school's budget in your subject-area (science or mathematics) in each of the following categories?

Expendable Supplies	$____________
Equipment	$____________
Duplication	$____________
Textbooks and other Print Resources	$____________
Media and Software	$____________
Total	$____________

Salish I Research Project
SIDESTEP - Part III
Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs

To be completed using the most reliable data available.

Date ______________________ School ______________________________

Teacher Name ____

Administrator Name (or other source) ______________________________

1. How would you classify the community served by your school?

    _____ rural; population < 2,000 (1)
    _____ small town; population 2,000-5,000 (2)
    _____ medium town; population 5,000-10,000 (3)
    _____ small city; population 10,000-25,000 (4)
    _____ medium city; population 25,000-100,000 (5)
    _____ large city-suburban; population > 100,000 (6)
    _____ large city-inner; population > 100,000 (7)

2. Please estimate the income of the families in the community(ies) served by your school, by percentage:

    _____% $15,000 or below
    _____% $15,001-$39,999
    _____% $40,000-$69,999
    _____% $70,000-$99,999
    _____% $100,000 or above

3. Approximately how many students are enrolled in your school? ______________

Appendix C

Teachers' Pedagogical Philosophy Interview (TPPI) Standard Operating Procedures, Questions, and Coding Scheme

Fourteen Selected Questions from Salish I Research Project Teachers' Pedagogical Philosophy Interview – First Year Teachers

3. Describe a well-organized classroom.
21. Describe the best teaching/learning situation that you have ever experienced?
22. In what ways do you try to model the best teaching/learning situation in your classroom?
23. What are some of the impediments or constraints in implementing that kind of model?
24. What are some of the tactics you use to overcome these constraints?
29. How do your students learn best?
30. How do you know when your students understand a concept?
33. In what ways do you manipulate the educational environment to maximize student understanding?
38. How do you accommodate students with special needs in your classroom?

42a. Which of your undergraduate education courses were beneficial to you when you began teaching? Why or why not?

42b. Which of your undergraduate education courses were not beneficial **to** you when you began teaching? Why or why not?

43a. Which of your undergraduate science courses were beneficial to you when you began teaching? Why or why not?

43b. Which of your undergraduate science courses were not beneficial to you when you began teaching? Why or why not?

44. What changes would you make in undergraduate education courses to make the experience more meaningful?

Salish I Research Project
Teachers' Pedagogical Philosophy Interview

Standard Operating Procedures

The Teachers' Pedagogical Philosophy Interview (TPPI) should be administered between the third and seventh months of each school year a teacher is in the study. It is best done face-to-face, but it can be done over the telephone if a face-to-face interview is not possible. TPPI sessions should be audiotaped and transcribed; interviewers may want to take notes as well. Researchers should insure that the NT is close enough to the microphone to be heard. Some of the questions are stated in terms of "science/mathematics." Researchers should read the appropriate discipline for the teacher being interviewed.

There are two versions of the TPPI — one for First Year Teachers (teachers in their first year of teaching) and one for Second or Third Year Teachers (teachers in their second or third years of teaching). Specific instructions for these versions are shown below. A good reference on interviewing is *Qualitative Research Methods* by M. O. Patton (1980, Sage Publications).

First Year Teachers

The TPPI for teachers who are in their first year of teaching consists of 44 Level I Questions and six Level II (optional) Questions. Ideally, this interview should be divided into two sessions. Questions 1-25 could be administered during the first session and Questions 26-44 (and 45-50, if desired) could be administered during the second session. The total interview time should be approximately 1 1/2 hours.

Second or Third Year Teachers

Teachers who are in their second or third years of teaching should be administered the 34-question Second or Third Year Teacher version of the TPPI. This version also includes 15 questions at Level II. The Level I section of the interview can be administered in one sitting. If both Level I and Level II questions are to be asked, as with the TPPI for First-Year Teachers, two sessions are ideal. The total interview time for the Level I Questions should be approximately one hour.

CODING SCHEME FOR TPPI

Format of the Coding Scheme

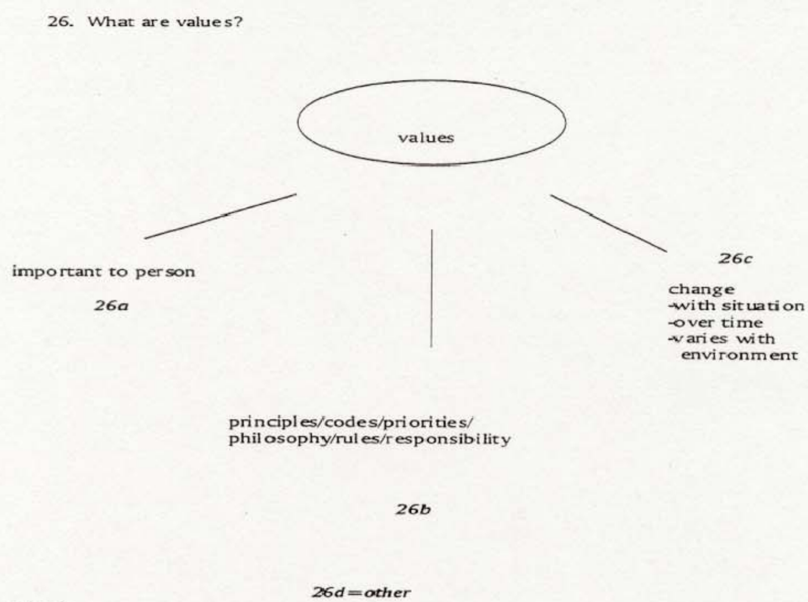
The following information provides an a priori coding scheme for categorizing data from TPPI interview transcripts produced for each year of data collected[11] . A teacher is the unit of analysis for this coding scheme. The codes emerged as a product of iterative discussions among Salish team members as they analyzed many interviews over two years. Three levels of analysis were built into the final scheme to code answers to the questions from the TPPI.

Level One Analysis

The first level of analysis is presented in the form of maps. Each TPPI question has a map of its own. Each statement on a map is a category for data extracted from an interview transcript. Each category has a code number and letter near it (see Figure 1).

Figure 1

A sample TPPI coding map



Level Two Analysis

The second level of analysis of the TPPI coding scheme is in the form of a matrix. The matrix for the second level of analysis shows which codes from the first level of analysis fit into which \ columns and rows on the matrix (see Figure 2). The categories (codes) from the first level of analysis were collapsed into categories called super codes and placed on the matrix. A super code is a row by columm code. It consists of a column heading indicating teacher style combined with a row heading labeling an aspect of what is happening in the classroom. The parameters for each super code category in the second level of analysis are the categories of the STAM. The categories

[11] (This coding scheme does not address question 5, or questions 45 and higher on either form of the TPPT. These items were not part of the final analysis for Salish I.

used as labels for columns are didactic, transitional, conceptual, early constructivist, experienced constructivist, and inquiry.

Figure 2

Excerpt from TPPI supercode scheme

	Teacher Styles Level 1 categories TEACHER CENTERED		CONCEPTUAL	STUDENT CENTERED		
Aspects of Classroom	Level 2 STAM categories DIDACTIC	TRANSITIONAL	CONCEPTUAL	EARLY CONSTRUCTIVIS	EXPERIENCE CONST.	INQUIRY
	Supercodes					
TEACHER/ CONTENT	TCDIDA	TCTRAN	TCCONC	TCEARL	TCEXPE	
	Level 1 TPPI codes					
	12a-d,g,i-m			12e,f,h,n-q		
	14a, b, h-j,o,p	14c-f, k-m				

The categories used as labels for rows represent what is going on in the classroom. ~~Some~~ Some categories were added beyond those of the STAM The labels are "teacher/content, self as teacher, student actions, environment, context, diversity, philosophy of teaching." The latter labels are called "aspects" herein. Each row heading actually contains several horizontal "rows". The boundary for each label is designated by darkened lines above and below the label. A teacher's style for a particular aspect is determined by combining the various TPPI response codes in each column between the dark horizontal lines for each aspect. The distribution of the codes across the columns determines the teacher's style for an aspect.

This first set of super codes enables the researcher to relate the self report data in categories that emerged from the TPPI interviews to categories in video taped classroom observation data analyzed with the STAM instrument. There were TPPI questions that corresponded to all the aspects. However, codes were not developed to correspond to all of the teacher styles in STAM.

Level Three Analysis

The third level of analysis of the TPPI coding scheme is also in the form of a matrix. The categories from the second level of analysis were collapsed into another set of super code categories. Didactic and transitional codes were combined in the teacher centered column, conceptual codes were placed in conceptual column, and early constructivist, experienced constructivist, and inquiry super codes from level two were combined into the student centered column for level three.

Getting Oriented to the Coding Scheme

Step 1. Read responses to a specific question on several transcripts to get an idea of the types of statements respondents made to that question.

Step 2. Read the descriptors of each category on the map that matches the question you just read. Determine your interpretation of the category (thus the interpretation of the code).

Coding an Interview Transcript

Level One Coding

Read the answer to the question in one transcript. Highlight text that appears to be relevant to one or more of the categories on the maps. Place the information into categories from the related map. Record the code numbers and letters of the category, or categories, related to a highlighted segment in the margin of the transcript. Where you have more than one code for a block of text, be sure to make it clear with lines or arrows which word or phrase stimulated you to place a particular code in that margin.

(Why would you highlight more than just the specific word, phrase, or sentence that fits into a category? The reason one may be highlighting more than just a phrase or a sentence in a specific paragraph is to preserve the context from which you are inferring a particular meaning and assigning the code. This is important when several people are coding the same material, because it helps researchers compare the types of statements they each used to assign data to a category (code) and reach consensus on codes. When highlighted/coded information gets separated from the original transcript, as it does when one uses a computer program to assist in coding and analysis, it makes the documentation for your interpretations and quotations visible.

Level Two Coding

Make a copy of the entire super code matrix for level two analysis found in this section of the instrument package for each teacher in your sample. Review one teacher's transcript at a time. Copy the code in the margin next to the highlighted portion of the text into the matching cell in the matrix. Proceed one question at a time.

When you have completed the matrix for a teacher, translate the codes in the cells into written paragraphs. This paragraph will reflect the distribution of the codes across columns. Construct each paragraph using the language describing the categories for level one the codes used earlier. In essence, you are decoding the matrix for a reader. Construct one paragraph for each aspect measured by the TPPI (e.g., teacher/content, self as teacher, student actions, etc.). One paragraph should describe the data across rows thus describing one aspect. Consider the distribution of codes across columns and choose from the following labels "didactic, transitional, conceptual, early constructivist, experience construtivist, and inquiry". There may be an array of responses in which case select the various labels that describe the data for each. Repeat this process for each set of TPPI super codes related to each aspect. Three examples of "paragraphs" appear at the end of this description of the TPPI coding scheme.

The extent to which teachers' responses on their TPPI's correspond with the TPPI codes that are identified in the column below each super code, you would decide which super code(s) describes the teacher in regard to that aspect. For example, codes of 12a, 14a, 15c, and 35a would receive the super code TCDIDA which indicates this teacher's responses related to teacher/content on the TPPI could be labeled didactic in a level two analysis.

A teacher's results may fall into more than one column indicating that the teacher's style varies. This makes it difficult to assign as single label and a researcher must make judgement calls based on self determined weighting of responses, being aware that the existance of the variety may have significant meaning.

Coding Level Three

For level 3 analysis, review each teacher's completed level two matrix in your sample, one at a time. Attend to the columns and heading created by the degrees of gray shading on the matrix. Write one paragraph for each aspect measured by the TPPI. Select from the labels "teacher centered, conceptual, and student centered" to orient each paragraph describing the teacher's self perception of what he/she thinks and does. Include data from the row for one aspect. For teacher centered, include all the cells shaded in medium gray. For conceptual, use the cells in the middle column of the matrix that are slightly shaded. For student centered, use all the cells shaded in the darker gray. These paragraphs will be entered into another matrix, the "Teacher Data Matrix", when data from various instruments are triangulated later in the study.

Next Step

In order to discuss a specific group of teachers related to a single aspect measured by the TPPI, or related to a specific program feature, a next step might be to lay one matrix over the other to summarize the number of teachers who answered a particular question in a particular way. Also, these paragraphs will become part of the Teacher Data Matrix that is used for comparing data about a teacher across several teacher data measures (instructions for creating this matrix are at the end of this teacher maesures section).

Salish I Research Project
Teachers' Pedagogical Philosophy Interview[12]
First Year Teachers

Level I Interview Questions

1. How would you describe yourself as a classroom teacher?

2. What role model do you have for yourself as a classroom teacher?

3. Describe a well-organized classroom. When you have your classroom running the way you want it, what is it like?

4. How did you form this model of the well-organized classroom?

5. How long did it take you to develop this model of teaching?

6. What do you consider to be the founding principles of teaching? If you had to write a book describing the principles that teaching should be built on, what would those principles be?

7. How do you learn best?

8. How do you know when you have learned?

9. How do you know when you know something?

10. What are facts, laws, and theories in science/mathematics?

11. How are facts arrived at?

12. How do you distinguish among facts, laws, and theories in science/mathematics?

13. When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner?

14. What is science/mathematics?

15. In what ways do you learn science/mathematics best?

16. When you learn science/mathematics, is it different than learning mathematics/science or history?

17. What are the founding principles of science/mathematics?

18. How do you decide what to teach and what not to teach?

19. How do you decide when to move from one concept to another?

20. What learning in your classroom do you think will be valuable to your students outside the classroom environment?

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[12]Developed by Lon Richardson and Patricia Simmons.

21. Describe the best teaching/learning situation that you have ever experienced.

22. In what way do you try to model that best teaching/learning situation in your classroom?

23. What are some of the impediments or constraints for implementing that kind of model in your classroom?

24. What are some of the tactics you use to overcome these constraints?

25. Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this?

26. What are values?

27. How do you arrive at these values?

28. What are some of the things you value most about science/mathematics?

29. How do you believe your students learn best?

30. How do you know when your students understand a concept?

31. How do you know when learning is occurring, or has occurred in your classroom?

32. How do you think your students come to believe in their minds that they understand something?

33. In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding?

34. What science/mathematics concepts do you believe are the most important for your students to understand by the end of the school year?

35. How do you want your students to view science/mathematics by the end of the school year?

36. What values do you want to develop in your students?

37. What are some of the things you believe your students value most about their educational experience in your classroom? When they leave here they say, 'I really liked (his/her) class because __________'.

38. How do you accommodate students with special needs in your classroom?

39. What do you believe are your main strengths as a teacher?

40. In what areas would you like to improve as a teacher?

41. When did you realize you were becoming a good teacher, understanding that you were having a positive effect on your students and satisfied that you were doing the right thing?

42a. Were your undergraduate education/pedagogy courses beneficial to you when you began teaching? Why or why not?

42b. Were your undergraduate science/mathematics courses beneficial to you when you began teaching? Why or why not?

43a. What changes would you make in undergraduate education/pedagogy courses, if you could, to make the experience more meaningful?

43b. What changes would you make in undergraduate science/mathematics courses, if you could, to make the experience more meaningful?

44. In reference to the teaching model or teaching package that you have developed.....if you had to divide that up into a pie chart, how much of that chart would come from undergraduate training, graduate training, your on-the-job experience, or anything else that you can think of?

Level II Interview Questions

45. How do you define truth?

46. Is there a relationship between science/mathematics and truth? What is that relationship (if yes)?

47. How do you define technology?

48. Is there a relationship between science/mathematics and technology? What is that relationship (if yes)?

49. How do you define society?

50. Is there a relationship between science/mathematics and society? What is that relationship (if yes)?

TPPI SUPER CODES

	Teacher Styles Level 1 categories TEACHER CENTERED		CONCEPTUAL	STUDENT CENTERED		
Aspects of Classroom	Level 2 STAM categories DIDACTIC	TRANSITIONAL	CONCEPTUAL	EARLY CONSTRUCTIVIST	EXPERIENCED CONST.	CONST. INQUIRY
	SUPERCODES					
TEACHER/ CONTENT	TCDIDA	TCTRAN	TCCONC	TCEARL	TCEXPE	
	Level 1 TPPI codes					
	12a-d,g,i-m			12e,f,h,n-q		
	14a, b, h-j,o,p	14c-f, k-m				
	11a,g	11c		11b,d,e,h		
	15d,g,k,l	15 c	15e,m	15b,f, h,n		
	17a-c,e-g,i,l	17k,n,o		17h,j		
		28a,c-f		28b		
			34e,h,i	34a,c,d,f	34b	
	35a	35b,e-l,p	35c	35m,o		
	SUPERCODES					
SELF AS TEACHER	STDIDA	STTRANS		STCONSTR		
	Level 1 TPPI codes					
	39a-d,j			39e-h		
	40a-e,l			40f,g,h,i,j		
	41m,n			41f-j		
3	3a,e	3b,d,f-i		3c,j		

	SUPERCODES					
TEACHER ACTIONS	**TADIDA**	**TATRAN**	**TACONC**	**TAEARL**	**TAEXPE**	
3	3a,e	3b,d,f-i		3c,j		
	18a,b	18c,d,h,i		18e,f	18g	
	19f,d, h	19c,e,j-l		19a,i	19b	
23	23f-n,p			23a-e		
24	24a,e,f		24c	24b		
	33b,k	33a,c,d,l	33f-h	33e,i,m		
STUDENT ACTIONS	**SADIDA**	**SATRAN**	**SACONC**	**SAEARL**		**SAINQU**
29	29d,e,p	29c	29b,g,l,m,o	29f,h,i,k,n		
	31g,h	31i		31a-d,f		31k
30	30a,c,h	30g	30b,d,e	30j		30i
	32a-d,f-h			32e		
33	33b,k	33a,c,d,l	33f-h	33e,i,m		
	35a	35b,e-l,p	35c	35m,o		
38	38g	38c,f	38a,b,e			
ENVIRONMENT	**ENVTCHCN**			**ENVSTUCN**		
	37b,i,j,l,n			37a,c,d,e,f,k,m		
	SUPERCODES					
CONTEXT	**CONTCHCN**			**CONSTUCN**		
23	23f-n,p			23a-e		
24	24a,c,e,f			23b		
	25d,f-i			25e		

	SUPERCODES					
DIVERSITY	DIVDIDA	DIVTRAN	DIVCONC			
38	38g	38c,f	38a,b,e			

PHILOSOPHY OF TEACHING	PTDIDA	PTTRAN	PTCONC	PTEARL	PTEXPE	PTINQU
	6d,g,k,n			6a-c,e,f,m-o		
	7a-d,m	7j		7e,f,h	7g	
	8a		8j,k,m	8b-g	8h	
	9a		9c	9b,d		
	13h-j			13a-g,l		
	15d,g,k,l		15e,j,m	15b,f,h,n		
		16g,o	16b-e,j,l,n	16h,k,m		
	20d		20a,f	20b,c		
21	21d,e,g,i,n,q,r			21 l,m,o,p		
22	22e,g,h,k,q	22a,b,i,j	22f,l, p	22c,d,m	22n	
29	29d,e,p	29c	29b,g,l,m,o	29f,h,i,k,n		
30	30a,c,h	30g	30b,d,e	30j		30i

Appendix D

Science Teacher Analysis Matrix (STAM), Standard Operating Procedures, Unit Content Journal, and Daily Journal

Analyzing the Video and Observational Data

The video and, or, observational data are analyzed using Cultural Diversity Scale and the coding scheme of the Secondary Teacher Analysis Matrix (STAM). The Cultural Diversity Scale is a questionnaire addressing how a teacher deals with nine dimensions of cultural diversity. It is filled in by the researcher after watching the video tapes. The researcher rates a teacher's actions for each of the nine cultural diversity dimensions. One summary paragraph consisting of nine statements is then written. This paragraph is put into a Teacher Data Matrix described later in this instrument package.

There are two versions of STAM, one for mathematics and one for science. Directions for using STAM, and directions to write a video summary of STAM, are included on each version. The video summary is inserted in a Teacher Data Matrix described later in this instrument package.

The STAM is a matrix. Teaching styles are used as labels for the six columns. They are didactic, transitional, conceptual, early constructivist, experiences constructivist, and constructivist inquiry. Dimensions of what is going on in the classroom are used as labels for rows. There are twenty-two rows: (1) Structure of content, (2) Examples and connections, (3) Limits, exceptions, and multiple interpretations, (4) Processes and history of science/mathematics, (5) Methods, (6) Labs, demos, hands-on labs for science, hands-on, calculators, computers for mathematics, (7) Teacher-student interactions about subject matter, (8) Teacher's questions focused on ..., (9) Kinds of assessment, (10) Uses of assessment in addition to grading, (11) Teacher's responses to students' ideas about subject matter, (12) Writing and other representations of ideas, (13) Students' questions, (14) Student/student interactions about subject matter, (15) Student initiated activity, (16) Students' understanding of teacher's expectations, (17) Richness of resources, (18) Uses of resources, (19) Access to resources, (20) Decision making, (21) Teaching aids, (22) Students' work displayed. Groups of rows are combined into areas labeled as follows: Rows 1- 4 are combined into the area labeled, Content. Rows 5-11 are labeled Teacher Actions. Rows 12 - 16 are labeled Student Actions. Rows 17-19 are labeled Resources. Rows 20 - 22 are labeled Environment. The meaning of each cell is described in the table that follows on the STAM analysis forms. An example of a video summary follows this table.

Salish I Research Project
Video Portfolio/Classroom Observation
Unit Content Journal

Date ______________________ Teacher Name ______________________

School ______________________ Course Title ______________________

Grade of Class ______________________ Class Hours ______________________

Topic of Unit ____

Unit Content (key facts and concepts, processes, applications, attitudes, and habits of mind, i.e., ways of thinking like a scientist/mathematician addressed in the unit). This can be an outline, concept map, or any other representation that you choose. Please include enough detail so that you create a mental picture of the unit for an outsider.

Salish I Research Project
Video Portfolio/Classroom Observation
Daily Journal

Date ______________________ Teacher Name ______________________

School ______________________ Course Title ______________________

Day 1 2 3 4 5 TAPE # ______________________
(If you are taping)

Lesson Planning: Complete Questions 1-4 before you teach the day's lesson.

Topic of the Lesson: ____

1. Lesson content (key facts & concepts, processes, applications, attitudes, and habit of mind, i.e., ways of thinking like a scientist/mathematician included in this lesson).

2. What are your intended outcomes (i.e., goals, purposes, objectives)? How does this lesson contribute to your goals for the unit?

3. What knowledge, skills, attitudes, etc., did your students have prior to the lesson? How did you determine this?

4. Materials and/or text to be used. (Please include copies with your journal entries.)

Reflection: Complete Questions 5 and 6 at the end of the day's lesson.

_____ Number of students present.

5. Please summarize any activities that lasted at least three minutes.

<u>Activities</u> <u>How did this activity contribute to your goals</u>?

6. How do you know that your students learned what you wanted them to?

Complete the following question on Day 5 only, at the end of the unit of study.

7. If you were to redo this five-day unit of study, what would you change?

Secondary Science Teacher Analysis Matrix ©
J. Gallagher and J. Parker

Revised, August 1995
Michigan State University

Directions for Salish Project Use

ANALYSIS OF TEACHERS' JOURNALS

Analyze the Teacher's Journal first. Code each group of responses that pertain to one concept on a SSTAM Analysis Record. Enter a "J" in a particular color ink to distinguish this from video analysis. Do not forget the back of the form.

ANALYSIS OF VIDEOS

While reviewing a teacher's video tapes, you will complete three records:

- Record of Activities
- SSTAM Analysis Record - found inside of this folder
- Summary

Record of Activities

The Record of Activities is a catalogue of the classroom activities and transitions seen in the video. It should include the tape number, the date the tape was made, A or T designating activity or transition, the beginning time of the activity or transition, and a brief description of each activity or transition. A sample entry follows.

Date	Tape #	A or T	Start time	Description
2/8/95	1	A1	0:00	T explaining "Create a Baby" act.
		T1	0:13	Transition to groups
		A2	0:16	Group work creating baby's genes

This signifies that this first tape was made on 2/8/95 and the major activities were the teacher explaining to the class how they will "Create a Baby" which starts at the beginning of the class and group work following it in which students created a fictitious baby's genetic make-up.

The Record of Activities will be used in two ways: (1) as a reference for the SSTAM Analysis Record and (2) as a reference for further analysis of the videos. For the example given above, the Activity 2 could be cited as 1.A2 on the SSTAM Analysis Sheet. That would mean Tape 1, Activity A2.

SSTAM Analysis Record

We suggest that analysis be done by two, or even three people watching the tape together, especially as you learn to use this Matrix. Become familiar with the full matrix first. If an entry on the Analysis record seems unclear, refer to the full matrix. You may wish to make notes on the Analysis Record as you watch the tape.

- Use one SSTAM Analysis Record for the three tapes. Use a different color for each class session.
- After you have watched an entire class session, stop the tape. Code each activity and transition on the SSTAM Analysis Record as completely as possible. To designate an impression that comes from the entire class session instead of from a particular activity, use 1X, 2X, etc. where the number identifies the class session.

Summary

The summary consists of six paragraphs: an initial paragraph describing the teacher's overall teaching style with whatever qualifiers seem necessary; one paragraph for each of the five areas in the matrix. These five paragraphs should include at least one sentence for each of the 22 dimension of the matrix. At the end of each sentence enter the three cell designations that best describe what you saw on each of the three tapes. Example: 14. Student-student interaction dealt with procedures and correctness of homework answers. D1: 14BC, D2: 14C, D3: 14B

Secondary Science Teaching Analysis Matrix
J. Gallagher & J. Parker
May 1995 © Revised August 1995

CONTENT

A Didactic	B Transitional	C Conceptual	D Early Constructivist	E Experienced Constr.	F Constructivist Inquiry
• Factual content, *factoids*	• Content tends to be *descriptive* with concepts and factoids given equal emphasis	• Content tends to be *explanatory* with conceptual content organized around key ideas	• Teacher and students negotiate understanding of *key ideas* with teacher's content emphasized	• Teacher and students negotiate understanding of *key ideas* based in students' ideas & content	• *Investigations* dominate content. Conceptual content and connections embedded into design, implementation, analysis, and report of investigation
• No examples or interconnections to: a) real world events b) related ideas c) key ideas of the subject	• Real world examples and/or related ideas separate from other pieces of content	• Examples and connections made by teacher to: a) real world events b) related ideas c) key ideas of the subject	• Teacher leads students in using examples and constructing connections to: a) real world events b) related ideas c) key ideas of concept	• Connections constructed by students with teacher's guidance to: a) real world b) related ideas c) key ideas of concept	• Connections constructed by students are related to investigation, data analysis, and concept building
• Over simplified so that the limits or exceptions within content are not presented. Many statements are absolutes without qualifiers.	• Some limits, exceptions, and alternate interpretations included, but are not integrated with other content.	• Limits, exceptions, and alternate interpretations are presented as part of the content	• Teacher leads students to identify limits and exceptions that may generate alternate ways of representing or interpreting observations and events	• Teacher and students identify limits and exceptions that may generate alternate ways of representing or interpreting observations and events	• Teacher and students identify limits, exceptions, and alternate interpretations by applying knowledge to part of problem solving
• No explicit mention of how we know. Scientific method is presented separately as rote procedure	• No explicit mention of how we know. Processes of science (observation, inference, experiment, etc.) are not integrated with content	• "How we know" included in content. Teacher integrates processes of science with concepts.	• Teacher leads students to reconstruct how evidence has been used to formulate scientific ideas and to use scientific processes to formulate and evaluate ideas	• Students, with teacher's guidance, reconstruct how evidence has been used to formulate scientific ideas and to use scientific processes to formulate and evaluate ideas	• Processes of science applied to design of project investigation, data collection, data analysis, and concept building

TEACHER'S ACTIONS AND ASSESSMENT

A Didactic	B Transitional	C Conceptual	D Early Constructivist	E Experienced Constr.	F Constructivist Inquiry
• 1 or 2 teaching teacher-centered methods predominate	• 3 or 4 teacher-centered teaching methods, including some hands-on	• Rich repertoire of teacher-centered teaching methods, including hands-on	• Some use of student-centered methods such as group work, student writing, discussion, and concept mapping.	• Extensive use of student-centered methods	• Project method with teacher and students selecting methods of inquiry and analysis, guided by questions being investigated
• Demonstrations, labs, and hands-on activities are rare	• Some demonstrations, labs, or hands-on activities which are either overly directed (cookbook) or undirected (e.g. exploration without follow up)	• Many demonstrations, labs, or hands-on activities that are conceptually focused. "Answers" generally known ahead of time	• Investigations, demonstrations, and hands-on activities lead by teacher and incorporate some students' ideas	• Investigations, demonstrations, and hands-on activities are constructed by teacher and students and build on students' ideas	• Demonstrations and hands-on activities are part of longer term investigations. Students have a high degree of input in generating question and planning investigation
• Little teacher-student interaction about subject matter (chalk and talk)	• Teacher-student interaction about correctness of students' ideas about unconnected facts	• Teacher-student interaction about correctness of students' knowledge of conceptual content	• Teacher-student interaction about clarification and usefulness of students' ideas and understanding is teacher-directed	• Students & teacher have input into the clarification and usefulness of students' ideas and understandings	• Teacher- student interaction focused on investigations with topics and goals of inquiries often determined by students.
• Teacher's questions call for factual recall	• Teacher's questions directed towards scientific ideas, not towards connections or applications They do not build on students' responses.	• Teacher's questions are directed towards knowledge of scientific concepts and their connections and applications. They do not build on students' responses.	• Teacher's questions are goal-oriented and occasionally emerge from students' responses. They are used to clarify students' ideas.	• Teacher's questions are goal-oriented and frequently emerge from students' responses. They are used to clarify students' ideas.	• Teacher's questions are goal-oriented, emerge from student's responses, and are used to guide investigations
• Tests and quizzes only	• Occasional checking, in addition to tests & quizzes, of students' knowledge	• Frequent checking, in addition to tests & quizzes, of students' knowledge	• Multiple forms. Some assess students' knowledge. Some assess students' understanding.	• Multiple forms. Most assess students' understanding.	• Multiple forms arising from investigations and presentations.
• None	• Checking students' knowledge	• Checking students' knowledge and preplanning	• To guide teacher in adjusting activities.	• To guide teacher and students in adjusting and carrying out activities	• To guide teacher and students in making adjustments in investigations and analysis
• Teacher disregards students ideas about subject matter	• Teacher may accept all students' ideas. Teacher views students' unscientific ideas as oddities.	• Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas	• Teacher occasionally seeks students' ideas and considers them in instructional decision making this information some of the time in designing activities	• Teacher actively seeks student's ideas. Assessment drives instructional decision making.	• Treats students as self-directed learners and interacts as co-investigator

Secondary Science Teaching Analysis Matrix
J. Gallagher & J. Parker
May 1995 © Revised August 1995

STUDENTS' ACTIONS

A Didactic	B Transitional	C Conceptual	D Early Constructivist	E Experienced Constr.	F Constructivist Inquiry
• Writing and other representations of ideas not used. Short answers predominate	• Writing and other representations of ideas rarely used. Most are reconfigurations of information provided.	• Several forms of writing and other representation of ideas are used. Most are reconfigurations of information provided.	• Students occasionally use writing and other representations of ideas as part of developing their understanding and constructing meaning. Much is reconfiguring information provided.	• Students frequently use writing and other representations of ideas as part of developing their understanding and constructing meaning	• Students choose from a variety of forms of writing and other representations of ideas as part of developing their understanding and constructing meaning
• Few student questions	• Student questions clarifying procedures dominate. Some questions ask for clarification of terminology or repeat of information	• Student questions focus on clarification of meaning related to specific concepts or procedure	• Some student questions focus on clarification of meaning related to specific concepts. Some address key ideas, their connections and applications. Few are procedural.	• Student questions address key ideas, their connections and applications	• Student questions address key ideas, their connections and applications in the context of a long-range, investigative framework
• Student-student interaction is rare.	• Some student-student interaction, mostly about procedure	• Some student-student interaction about procedure. Some about articulating scientific ideas correctly	• Some student-student interaction directed toward understanding and applying scientific ideas. Some about procedure	• Student-student interaction directed toward understanding and applying scientific ideas. Students are self-reliant	• Student-student interaction is frequent and is directed toward understanding and planning. Students are very self-reliant
• Students rarely volunteer examples or analysis	• Students volunteer a few examples, but connections to class activities may be weak	• Students volunteer some examples related to class activities	• Students volunteer analysis as well as examples. Some are related to class activities. Others are weakly related.	• Students volunteer analysis as well as examples. Most are pertinent to class activities	• Students volunteer analysis and examples that are used in setting the direction of the class
• Students are passive or ignore teacher's procedures	• Students show confusion over procedures	• Students accept procedures and role	• Students demonstrate some frustrations with role. For example, "Why doesn't the teacher just tell me the answer?"	• Students do some negotiating with teacher of procedures and role	• Students help define their role in the investigation

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RESOURCES

A Didactic	B Transitional	C Conceptual	D Early Constructivist	E Experienced Constr.	F Constructivist Inquiry
• Little beyond single text or format	• Text and small number of other resources, including some hands-on	• Multiple resources, i.e. visual aids, videos, manipulatives, laboratory materials, technology, or people	• Multiple resources i.e. visual aids, videos, manipulatives, laboratory materials, technology, or people	• Multiple resources i.e. visual aids, videos, manipulatives, laboratory materials, technology, or people	• Multiple resources i.e. visual aids, videos, manipulatives, laboratory materials, technology, or people
• Students look at, but do not actively use resources. Resources may not be related to content	• Resources are not related to content	• Resources are related to content and illustrate ideas	• Some resources are used to aid students' understanding and application of ideas	• Many resources are used to aid students' understanding and application of ideas	• Resources are integrated into and arise from investigation
• Access to resources controlled by teacher	• Access to resources controlled by teacher	• Access to resources controlled by teacher, but there is some discussion of access with students	• Access to resources is guided by teacher with some discussion of access with students	• Access to resources is based on teacher/student negotiation	• Access to resources is guided by the investigation question

ENVIRONMENT

A Didactic	B Transitional	C Conceptual	D Early Constructivist	E Experienced Constr.	F Constructivist Inquiry
• Teacher-dominated	• Teacher-controlled. Little sharing of decision making with students.	• Teacher-controlled. Some sharing of decision making with students about use of time.	• Students & teacher make some joint decisions about time and activities	• Students & teacher make many joint decisions about time and activities	• Students & teacher make joint decisions about nature of and procedures for investigation
• Few teaching aids displayed. May not be integrated with content	• Some teaching aids displayed. May not be related to content	• Many teaching aids displayed related to content	• Many teaching aids displayed related to content	• Many teaching aids displayed related to content. Some are made by students	• Many teaching aids displayed derived from investigation
• Few examples of students' work displayed	• Students' work displayed is typically similar for all students (i.e. worksheets or identical models)	• Some variation in students' work displayed	• Students' work displayed, includes some student creations (i.e. original posters, stories, or demos)	• Students' work displayed, includes many student creations (i.e. original posters, stories, or demos)	• Students' work displayed, includes student creations derived from investigation

REFLECTION

Focus of Reflection	Extent of Reflection: Description	Analysis	Action Plan
Teacher			
Logistics			
Ss' understanding			
Ss' affective response			

Reflection focus	Self					Students

Examples
1. Reflection focused on students' understanding, including an action plan: "The students didn't make the connection between buoyancy and pressure in the Cartesian diver, because I didn't talk about it enough. Tomorrow I will repeat that point." This entry would be scored with a line across the top 3 boxes, because it contains a description, analysis of the cause of a problem, and suggested action.

2. Descriptive reflection focused on logistics: "This lab was too long. "This entry would be scored in the left-hand box next to “Logistics” since there is no analysis or action plan.

OTHER FACTORS

Accuracy of content	low				high
History of scientific ideas	none included				integrated in content
Quality of S/T inter-personal interactions	hostile		neutral/ passive		cooperative
Quality of S/S inter-personal interactions	hostile		neutral/ passive		cooperative
Student behavior	disruptive		neutral/ passive		cooperative
Student engagement	off-task				on-task
Transitions	poorly organized prolonged				natural smooth
Use of time	much down time				well organized
Facilities	directed towards teacher, unchanging				flexible changed frequently

STAM Analysis Record - Science Version

Secondary Teacher Analysis Matrix - Science Version
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May, 1995 © Revised October, 1995

	TEACHING STYLE	A. DIDACTIC	B. TRANSITION	C. CONCEPTUAL
CONTENT	*1. Structure of content*	*factoids*	*descriptive*	*explanatory*
CONTENT	2. Examples & connections	none	not integrated	made by T
CONTENT	*3. Limits, exceptions, & multiple interpretations*	*not present*	*some included* *not integrated*	*part of content*
CONTENT	4. Processes & History of science	rote scientific method	not integrated	integrated by teacher
TEACHER'S ACTIONS	*5. Methods*	*1 or 2 T-centered*	*3 or 4 T-centered*	*many T-centered*
TEACHER'S ACTIONS	6. Labs, demos, hands-on	rare	cookbook or undirected	conceptually focused
TEACHER'S ACTIONS	*7. T-S interactions about subject matter*	*little*	*about unconnected ideas*	*about conceptual content*
TEACHER'S ACTIONS	8. T's questions focused on...	factual recall	unconnected ideas	concepts & connections
TEACHER'S ACTIONS	*9. Kinds of assessment*	*tests & quizzes only*	*occasionally others*	*frequently others*
TEACHER'S ACTIONS	10. Uses of assessment in addition to grading	none	checking Ss' knowledge	checking Ss' knowledge & preplanning
TEACHER'S ACTIONS	*11. T's responses to Ss' ideas about subj. matter*	*disregards*	*accepts all ideas*	*seeks to change unscientific ideas*
STUDENTS' ACTIONS	12. Writing & other representations of ideas	short answers	different reconfigurations of info. provided: rare	several
STUDENTS' ACTIONS	*13. Students' questions*	*few*	*procedural*	*procedural & conceptual*
STUDENTS' ACTIONS	14. S/S interactions about subject matter	rare	about procedure	about correctness
STUDENTS' ACTIONS	*15. Student-initiated activity*	*Ss volunteer examples:* *rare*	*few*	*some*
STUDENTS' ACTIONS	16. Ss' understanding of teacher's expectations	Ss passive or ignore procedures	confusion over procedure	expectancies accepted
ENVIRON. RESOURCES	*17. Richness of resources*	*little beyond single format*	*small number, some hands-on*	*multiple*
ENVIRON. RESOURCES	18. Uses of resources	looked at only, not related		related to ideas
ENVIRON. RESOURCES	*19. Access to resources*	*T-controlled*		*some discussion*
ENVIRON. RESOURCES	20. Decision making	T-dominated	T-controlled	some discussion of time use
ENVIRON. RESOURCES	*21. Teaching aids*	*few*	*some* *may not be integrated w/ content*	*many, related to content*
ENVIRON. RESOURCES	22. Students' work displayed	similar from all Ss: few	some	many

Date of Analysis:
Teacher:
Analyst:

<table>
<tr><th>D. EARLY CONSTR.</th><th>E. EXPERIENCED CONSTR.</th><th>F. INQUIRY</th><th></th><th></th></tr>
<tr><td colspan="2">T & Ss negotiate understanding</td><td rowspan="2">investigations dominate</td><td rowspan="2">1</td><td rowspan="7">CONTENT</td></tr>
<tr><td>T's content</td><td>based in content & Ss' ideas</td></tr>
<tr><td>lead by T</td><td>constructed by T & Ss</td><td>constructed by Ss</td><td>2</td></tr>
<tr><td colspan="2">identification & use</td><td rowspan="2">as part of problem solving</td><td rowspan="2">3</td></tr>
<tr><td>lead by T</td><td>constructed by T & Ss</td></tr>
<tr><td colspan="2">use of process to formulate ideas</td><td rowspan="2">applied to investigations</td><td rowspan="2">4</td></tr>
<tr><td>lead by T</td><td>constructed by T & Ss</td></tr>
<tr><td colspan="2">S-centered</td><td rowspan="2">question dependent</td><td rowspan="2">5</td><td rowspan="13">TEACHER'S ACTIONS</td></tr>
<tr><td>some</td><td>extensive</td></tr>
<tr><td colspan="3">build on Ss' ideas</td><td rowspan="2">6</td></tr>
<tr><td>lead by T</td><td>constructed by T & Ss</td><td>guided by question</td></tr>
<tr><td colspan="2">clarification & usefulness of Ss' ideas</td><td rowspan="2">S input into goals</td><td rowspan="2">7</td></tr>
<tr><td>T-directed</td><td>T & Ss have input</td></tr>
<tr><td colspan="3">emerge from Ss' ideas & instr. goals</td><td rowspan="2">8</td></tr>
<tr><td>occasionally</td><td>frequently</td><td>guiding investigation</td></tr>
<tr><td colspan="3">multiple forms of assessment</td><td rowspan="2">9</td></tr>
<tr><td>of knowledge & understanding</td><td>mainly of understanding</td><td>arise from investigation</td></tr>
<tr><td colspan="2">adjusting activities</td><td rowspan="2">T & Ss designing investigation</td><td rowspan="2">10</td></tr>
<tr><td>by T</td><td>by T & Ss</td></tr>
<tr><td>considers in instr.. decisions</td><td>assessment drives T's decisions</td><td>T is co-investigator w/
self-directed Ss</td><td>11</td></tr>
<tr><td colspan="3">Ss use to construct meaning</td><td rowspan="2">12</td><td rowspan="7">STUDENTS' ACTIONS</td></tr>
<tr><td>occasionally/some reconfig.</td><td>frequently</td><td>Ss choose form</td></tr>
<tr><td>some conceptual, some procedural</td><td>mainly conceptual</td><td>conceptual, applied to investigation</td><td>13</td></tr>
<tr><td>some about procedure
some about understanding</td><td>about understanding</td><td>about understanding & planning</td><td>14</td></tr>
<tr><td colspan="3">Ss contribute examples and analysis</td><td rowspan="2">15</td></tr>
<tr><td>may be weakly connected</td><td>pertinent</td><td>guide class direction</td></tr>
<tr><td>frustrations w/ role</td><td>role & procedures negotiated w/ Ss</td><td>Ss define role</td><td>16</td></tr>
<tr><td colspan="3">multiple resources</td><td>17</td><td rowspan="4">RESOURCES</td></tr>
<tr><td colspan="2">aid understanding & application</td><td rowspan="2">integrated into investigation</td><td rowspan="2">18</td></tr>
<tr><td>some</td><td>many</td></tr>
<tr><td>T-guided</td><td>negotiated by T & Ss</td><td>guided by question</td><td>19</td></tr>
<tr><td colspan="3">joint decision making</td><td rowspan="2">20</td><td rowspan="6">ENVIRON.</td></tr>
<tr><td>some</td><td>much</td><td>applied to investigation</td></tr>
<tr><td colspan="3">made by Ss</td><td rowspan="2">21</td></tr>
<tr><td>some</td><td>many</td><td>derived from investigation</td></tr>
<tr><td colspan="3">Ss' creations</td><td rowspan="2">22</td></tr>
<tr><td>some</td><td>many</td><td>derived from investigations</td></tr>
</table>

Appendix E

Participant *STAM* Records

Richard's *STAM* Record

DATE	TAPE	T/A	START TIME	DESCRIPTION	PI STAM	AST. STAM
02/28/2002	1	T1	0:00	Teacher hands out lab sheet and asks students to get the materials they will need; Announcements are going over loud speaker as teacher hands out lab sheets		
				All students are quietly seated. Students take lab sheet from teacher and sit quietly.	16C	
		A1	0:02	Teacher takes silent roll and asks students to pair up and (tables of 4) as 2 person groups and then asks students to get goggles. All students get a pair of goggles from cabinet.	1C 2C 3A	1B 2C 3A
				Teacher hands out bread pieces and pre-cut paper pieces to each group. Student asks if everybody is supposed to have one. Teacher asks students to write their name and their partners name on lab sheet. Teacher points out safety concern that students should point test tube when heating away from direction of another student. Teacher tells students to retrieve test tubes from rack.		7C 8B 12B 13B 14C 15A
				Students light Bunsen burner with spark generator and then heat both materials separately in test tube. Teacher walks around room and assists students in lighting Bunsen burner and answering questions. Students note physical changes and times on lab sheet.	15A	

		T2	0:25	Teacher asks students to put test tubes in rack when finished. Teacher asks students to get out a piece of paper on their desk. Teacher asks questions about the lab such as "what did you notice?" "What was the appearance?" Students replies included: burnt, black, smelly, smoky." Teacher asks if there was anything else in the test tube. Student replies include "water and water vapor." Teacher repeats student responses and asks what is in every organic compound. Initially no student response and then a female student answers with "carbon."	4C 7C 8C	
		A2	0:29	Teacher gives notes on vocabulary terms on white board as students write down notes. Teacher faces board when writing notes and reading them to class. All students take notes initially but 3 students. One student has head down entire note-taking period. (After class, instructor answers observer's question by stating that particular student has an IEP). Teacher writes notes with student responses asking what covalent bonds, hydrocarbons, single, double, triple bonds are. Teacher asks students what gases are present in Bunsen burners, household gas lines, lighters. Student responses vary from helium, butane, to propane. One female student responded correctly from teacher correlation to TV show "King of the Hill" Teacher asks students to draw isomers of C3H8. One female student asked twice if her version was "right" and the teacher stated, "I don't know."	1B 2D 3A 7A/C 12A 16C	1B 2C 3A 7A 8A 13A 14A 15A 16C
				Teacher exhibits wait time with student questioning and not giving answer right away. Teacher defines covalent, ionic bonding and how the varying structures (isomers) will have varying characteristics, for example the more carbons, the greater the boiling point. Teacher refers to handwritten notes or book when giving notes.		
			0:45	Male students head down and eyes closed; female student leaves classroom after discussion with teacher		

			0:55	Five students are not taking notes. Teacher discusses and writes on white board how emitted ethylene from apples explains the old saying of one apple ruining the whole bunch.		
			0:59	Female returns quietly to classroom. Teacher mentions fat grams, unsaturated and saturated and asks if students have heard of these. Students do not reply. 3 students with head down.		
		T3	1:00	Teacher hands out worksheet and tells students they are going to construct as many models of octane that they can. One student from each table is to go to the front desk and retrieve marshmallows and raisons. Teacher tells the students to mark off gumballs on their lab sheet. Teacher puts out materials on front desk - two bags of small marshmallows, a couple of boxes of raisons and a box of toothpicks.		
			1:32	One male student with head down. Teacher states (verbally), the lab sheet states (written) and teacher writes on whiteboard (written) that the marshmallows signify the carbon atoms and the raisons the hydrogen atoms. The toothpicks signify the bonds between atoms. The teacher gives the empirical formula of C8H16. Student asks how many raisons and teacher tells her "well there are 8 carbons so there are16 hydrogens"		
		A3	1:36	Students on task constructing models except three African American males and one Caucasian male who are sleeping. (IEP) Students ask if they can do one together. At some tables, all four each make models. Teacher goes to each table and holds up completed student models for all to see. All made a straight chain octane first.	1C 2A 3A 13B	1B 2C 3A
			1:39	Teacher monitors tables by walking around and asking questions. Teacher asks non-participating male students "have you made any yet?" Teacher asks students to make another model. Teacher asks students to answer three questions on the bottom of the sheet. Teacher reiterates that different structures cause different properties.	7B 8A 9C	7C 8B 12B 13B 14B

						15A
		T4	1:49	Teacher asks students to have a seat and throw their constructed models away. Most students were in process of constructing second model.	22A 16C	16C
		A4	1:52	CLOSURE - teacher asks students to volunteer to come up and draw a butane molecule - One female student volunteers and goes up to draw on whiteboard. Teacher asks student to put drink away/up. Female student responds quietly by moving drink to table. Teacher asks all students how many bonds do carbon atoms form Male student answers "two," "three," and a female student says "four." Teacher asks "why four?" Teacher asks what do you call a different structure of the same formula. Female student answers isomer. Teacher says to expect quiz tomorrow and Biological compounds Monday and Test Tuesday.	1A 2A 3A 8A	1A 2C 7A 8A 12A 13A 14A 15A
		END	1:59	Bell		
03/02/2002	2	T1	0:00	Announcements over intercom - Teacher draws benzene ring structure on board. Teacher takes silent roll with grade book at desk in front. Nineteen students present at beginning of class. Two more female students arrive to class during the period. Teacher asks if anyone has seen "Deborah." Students socialize with each other. One moment of silence and pledge of allegiance conducted by all students and teacher.		
		A1	0:06	Teacher hands out quiz paper to each student. Students begin on quiz once they have paper.	1A 2A 3A	1A 3A 8A

			0:07	Female student finishes quiz and turns in paper to teacher. Teacher walks around room and collects completed quiz papers from each student as they finish. Teacher looks over quiz as students finish. Some students copy answers or look off other students' papers as teacher walks around room	12A	13A 14A
			0:10	Two female students complete quiz and give to teacher. Students finished with quiz wait quietly while others finish.		
			0:15	All students are finished with quiz and teacher reads each quiz question and gives answer or students give answer aloud. Teacher remarks that all students except one had trouble with Question 3. One female student (the one finished in a minute) gave the correct answer to question number three.		7A 8A
		T2	0:18	Teacher hands out typed notes for the day to each student. The notes are sentences from the book with omitted words. Teacher asks the students to close their eyes and to trust him. All students close eyes. Teacher walks around to each student and places a bag of wintergreen LifeSavers under each students nose. Teacher asks students to identify substance. Students remark that they know what the smell is. Students raise hands to state what the item is. Teacher then walks room with a jar of mothballs in the same manner.	4C 15B	
			0:23	Teacher asks students what the first thing was. Students respond and teacher asks students what the second thing was. Students' remarks include: "smells like old people" "that stinks" "I know what that is." "what was that dude; smells like those little heart things." Teacher asks for students to open eyes and then distributes a lifesaver piece of candy to each student. Teacher states that students have just identified two aromatic compounds. One male student is viewing a personal magazine.	4C	

		A2		Teacher reads worksheet and students complete sheet with answers. One female student gives answers as she is following along in the book. The worksheet and examples are from the textbook. Teacher discusses that different cheeses on cheeseburger are a result of different hydrocarbons. Teacher discusses benzene and its uniqueness by reading a sheet printed from the internet. Teacher reads about properties and what products benzene is found.	1A 2C 3A	1B 2C 3A 13A 14A 15A
		T3	0:44	Teacher hands each student a worksheet and a model kit to begin constructing 10 carbon structures. Students write the chemical and structural formula and then construct each organic compound. Teacher writes on the board the Key for the colored wooden balls. Teacher instructs students to use textbook for example of structural chemical formula. Teacher initially states for students to bring completed models to him; however, he decides to go to their tables to verify structure.		
		A3	0:45	Students begin constructing models. When finished with one structure, students raise hand. Teacher walks around to each student with hand raised and marks paper with a red check if structure is correct. Teacher asks student "what is this" referring to the structure and has the student name it. All students, but one, participate in activity by constructing models. Teacher instructs students to share things from models to make the more complicated structures.	1C 2A 3A 7C 12A	1B 2D 3A 7C 8C
			0:55	One new student does not open kit or make any models. She writes her name multiple times on her paper. When teacher asks about building a model, she tells him she is transferring to another school tomorrow.		12C 13B 14C 15A
			1:05	Students discuss with each other how to construct models from book. A male student asks a female student "where did you get isobutane?"	14B	
			1:14	One male student lays head down. He has not completed the 10 model		

				constructions.		
		T4	1:20	Students finish models. One female student enters class late and takes quiz. One female student assists student in taking quiz by providing answers on quiz. Two female students out of twenty-one students complete all ten models and questions on worksheet.		
			1:25	Students give completed sheets to teacher and return all model pieces to box and place box in middle of table.		
			1:28	Teacher requests that students turn in sheets. Reminder that Monday is notebook check day		
		END	1:30	Bell		
				OVERALL COMBINED LESSON CODES	5B 6C 9C 10B 11C 17C 18D 19D 20B 21B 22A	4C 5C 6C 9C 10B 11C 17B/C 18D 19B/C 20B 21B 22A

Susan's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
01/29/2002	1	T1	0:00	Teacher takes roll and adult male enters room and separates two student desks		
			0:03	Teacher begins writing on white board		
			0:05	Teacher explains activity roles such as timer, recorder, colorer and the activity materials, which include tape, red pens, handout, and plastic discs. Teacher explains the following vocabulary terms: nonfunctioning protein, functioning protein, enzyme and chemical reaction while students listen. Teacher states that grading is a group and individual grade.	16A	1A 2C 3A 4A 6B 7A 13A 14A 17A
			0:14	Teacher reads list of pre-assigned groups and asks students to move to group area. Students go to group areas and rearrange desks to face each other. Teacher gets the materials for approximately half of the groups; the students get the materials from the other groups. There are 3 groups of 4 students and 1 group of 3 students.		
		A1	0:18	Teacher instructs students to work on activity. Teacher monitors around room answering student questions. Teacher visits each group and repeats directions on how to complete activity two to three times. Two students are asleep and remain asleep the duration of the class. While teacher helps one group, the remaining students socialize. At varying points during the activity, some students work on activity, some students walk around the class, and some	1C 2A 3C 7B 9C 13B	1B 2D 7C 8C 12C 13B

				students socialize. During some class intervals, only 4 students out of 17 are working on activity.	14B 16A 18D	14B
		T2	1:11	Teacher gathers the activity materials and asks students to return to their seat and realign the chairs. Teacher asks students to turn in lab sheets.	16A	
		A2	1:15	Teacher asks for group student responses to activity results. Students reply to teacher's questions without any paper or pencil on desk. Teacher asks about results for homozygous recessive, heterozygous and asks about an intermediate type. Teacher asks for students to respond to question on the capability of an intermediate type. Three students respond that an intermediate type is possible.	1C 2A 3A 8D 16A	1B 2C 7C 8A 13A 14A
		T3	1:19	Teacher disseminates homework papers and asks students to work on it the remaining class time. No student works on homework.	16A	
		E N D	1:29	Bell	16A	
01/30/2002	2	T1	0:00	Intercom Announcements and teacher conducts roll silently by viewing class		
				Teacher asks students about homework and hands out student folders		
				Students ask for extra copies		
		A1	0:10 0:12	Teacher turns on overhead and asks students about concept map Eight students have paper on desk and eight do not. One student has head down and covers face with book. Nine students begin to write on worksheet. Teacher asks student to stay after class.	1C 2A 3A 5D 16A	1B 2C 3A 5B 6C 7A

		T2	0:25	Teacher assigns groups and asks students to become experts in a certain area of genetics. Teacher answers procedural questions regarding assigned groups. Male student leaves class. Female student enters class. Teacher left out one student from group assignment and assigns him a group. Students move their chairs to work in assigned groups.	5D	
		A2	0:32	Teacher hands out transparency sheet and helps groups with assignment by going around to each group. Two students get out of seat to get textbook on counter.	1C 2A 3A 16A 19C	1B 2D 3A 7C 8C 12C 13B 16A
			0:45	4 students observed working on assignment and 12 students not working on assignment. Female student complains of too many interruptions.		
			0:49	Teacher observes one male student hitting another male student in the back of head with textbook. Teacher uses classroom phone to call office to report that two students will be going to the office. Teacher orders two male students to go to office. Security officer appears at door requesting paperwork.		
			0:50	Teacher inquires from students how presentations are going.		
			0:58	6 students working and 6 students not working on activity		
			0:59	Without teacher's knowledge, a male student leaves from class with tissue.		
			1:00	One of the male students sent to office returns		
		T3	1:10	All groups completed assignment and male student returned from blowing nose in hallway. Teacher disseminates evaluation forms for students to complete on the group presentations.	11C	

		A3	1:11	Teachers ask groups to give presentations one at a time. Students, as a group, go to the overhead and present their topic. Students applaud at the end of each presentation and complete the evaluation forms. Teacher sits at back of room on counter eliciting various groups to present on the concepts of co-dominance, incomplete dominance, multiple alleles and sex-linked traits. Teacher gives example of hemophilia as a sex-linked trait.	1C 2C 3A 9D 12D 16C	1B 2D 7C 8C 12C 13B 14C 16C
			1:15	Knock on door and second student sent to office returns. Students ask about what consequence the student received from the office.		
		T4	1:24	Intercom Announcements begin and teacher straightens room by aligning chairs and picking up papers. Students hand worksheet to teacher. Students line up at door. Classroom lights go out and teacher asks students to turn them back on. Teacher asks students lined up at the door if they understood the concepts. Teacher speaks with one student about how his behavior disrupts the learning environment.	10C 16A	
			1:29	Bell/END		
				OVERALL COMBINED LESSON CODES	4A 5D 6C 9D 15A 17D 18C 19C 20C 21D 22A	4A 5B 9C 11C 15A 16A 18C 19B 20B 21B 22A

Tanya's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
03/13/2002	1	T1	0:00	Bell - Teacher takes silent roll and reminds class the end of the term is today. All students are seated at bell. Male student asks if he can check his grade on the computer and teacher said "not today." Approximately three students have piece of paper on desk. Teacher has power point presentation on white board with beginning screen reading Pedigree.		
			0:05	Announcements are given over intercom. Teacher asks students to be quite and listen to announcements. Teacher encourages the moment of silence and then the students stand and recite the pledge of allegiance with the intercom.	16C	
			0:10	Teacher tells students to "get out a piece of paper for notes." Notes are in two sections.		
			0:11	Teacher asks if "anyone has seen or used a pedigree." Teacher repeats question. One student raises hand. Teacher asks about terms. Female student states dominant and recessive. Teacher asks "what did we do with the Gummi Bears?"	2C	
		A1		Teacher turns out lights and begins Power Point presentation on white board in front of room. Teacher asks what's male and what's female and who determines the sex. Teacher asks how many pairs of chromosomes we have. Male student replies 46. Teacher repeats the word "pairs." Class then states 23. Teacher asks "what are homologous chromosomes?" Male student responds "chromosomes that are the same size and shape." Teacher states the Y chromosome is small and explains that a karotype is a picture of the chromosomes. Teacher asks if	1B/C 2C 3A 14A	1B 2C 3A

				"everyone is with her so far."		
				Teacher is at front of room reading typed Power Point and adds material to the presentation verbally. All students are taking notes.	16C	
				Teacher asks "who shows X - more females or males?" Students answer "females." Teacher asks "why?" Student responds with "they have 2 X's." Teacher states "good reasoning, but the male shows more often - has only one X."	7D 11C	7C 8C
				Teacher uses white board to draw how the trait is listed as a superscript on the X chromosome.		
				Teacher asks "what is the letter for color blindness?" twice. Students respond with "C." Student asks if "all sex-linked traits are recessive?" Teacher responds "not always, but mostly." Teacher gives hemophilia as an example and asks if anyone knows what it is. Male student responds "when your blood won't clot."	2C 3A 13D	13C
				Teacher asks students if they know of anyone with color blindness. Students raise hands and teacher asks them if the person they know is a "man or woman." All students reply they are "men." Teacher states "like we said, more in males."	2D	15C
				Male student asks if "there are any sex-linked traits on the Y." Teacher replies the Y is smaller than the X, but it does have the Testes Determining Factor on it. Teacher states "we will talk about the X for our purposes."	13D	
				Teacher shows diagram on Power Point of cross. Student asks "but can he pass that on?" Teacher replies "uh, huh." Teacher discusses how Drosophilae are used for crosses and students may use them in AP or college. Male student asks if hemizygous is the same as homozygous. Teacher says "right, for the male."	13C	14A

		T2	0:25	Teacher states before they go on with notes, they will "practice." Teacher handed out a teacher-constructed typed worksheet with five word problems. Teacher explains for students to use big X and big Y and for a superscript for the trait. Teacher states they may use partners and would finish quickly as it is only five problems.		
		A2	0:26	All students work on worksheet - some individually and some in groups. Teacher walks through rows of chairs assisting students with questions.	16C	2D
			0:37	Teacher asks "who has the first one and do they feel confident about their answer?" Teacher tells student with hand raised "to go to board and write example."	1C 2C 3A	3A 4C
			0:40	Teacher asks "who has the second one and do they feel confident about their answer?" Teacher tells student with hand raised "to go to board and write example for us."		
				Two male students discuss probability. One male states that "if you flip a coin and it lands tales, then the next time there is a 100% probability it will be heads." Another male student disagrees.	14D	12D 13C 14D
				Teacher asks "who has the third one and if they feel confident about their answer?" Teacher tells student with hand raised "to go to board and write number 3 for us." One student with literature book on desk.		15C
				Two male students discuss probability again. One male states that "if you flip a coin and it lands tales 100 times, then you have a 1% probability of getting 100 heads." Another male student disagrees.	14D	
				Teacher is discussing with student group about "genetic counseling being a big thing." Male students ask about parents having to undergo counseling. The Teacher's Edition textbook lies openly on shelf under computer.		
		T3	0:55	Teacher says it is time to check answers. Teacher tells students to copy these down.		

				Some students reply "I didn't get that." Teacher asks student to read question to her and then explained the student error. Teacher states "to be sure and read carefully because that is an easy mistake to make." Male student goes to board to explain his answer.	3A 15C	
		A3	0:56	Teacher tells students to "get out those notes." Teacher states to class "it is my turn to talk again and put the candy away."		
				Teacher gives definition of pedigree from Power Point presentation and states that it is on the Gateway exam (end of course Biology exam for Tennessee) usually. Teacher states it has been a "sex-linked trait every time she has seen the sample questions." Teacher discusses pedigree symbols. All students actively take notes.	1B 2C 3A 16C	1B 2C 3A 4A
				Male student states that the square, signifying male, would never be 1/2 shaded. Teacher states "you are right, males cannot be carriers; good point."	15C	
				Female student gets up from chair and throw item in trash. No permission need and no comment from teacher.	14A	14A
				Male student asks if children on pedigree are in birth order. Teacher states that "it doesn't matter and it depends on the one who made the pedigree." Teacher states that the pedigree can help find the genotype from the phenotype.	13B	13C
			1:01	Teacher turns lights on and gives out sheet (prepared from Gateway material package). Teacher states after this they will sing a song "I am my own grandpa." Female student responds "sounds like a Tennessee song." Teacher responds "get busy."		
				Some students work individually and some work in groups. Student discussion is centered around figuring out the questions regarding the pedigree. Two students ask if they write a conclusion. One student paper had the hypothesis that "males will have color blindness."		

		T4	1:15	Teacher hands out worksheet titled the ultimate pedigree with a song retrieved from internet. Teacher reads song on sheet and asks students to draw a pedigree of the song. Male student exclaims "I want to do that" Teacher states "good luck" to the class.		
		A4	1:17	Male students says "this is crazy." Another male student says "are we actually suppose to do this?" Teacher replies "yes." Male student asks "What do we call them." Teacher replies "individual one and individual two." Teacher states that you must draw a key. Two male students ask "no traits, right?" Teacher responds, "right, just relationship to another."	1B/C 2C 3C	2D 3A 4C
				Teacher asks class to "listen up" and to "come get this off stool" (holding worksheet) This is homework. (worksheet from textbook) Teacher states it is just one sheet back and forth.		7C 8C
			1:18	Teacher states there is 12 minutes left in class and that homework is more practice with pedigree. Teacher walks around room looking at students' pedigree.	12A/B	12D
			1:21	Student discussion about pedigree include "widow had daughter and he marries her" "that is a lot of inbreeding going on." All students pick up homework from stool when pedigree is finished.		13B
				Teacher walks around room and states "guys make sure you clean up your mess and put the pedigree in your notebook." Teacher discusses make-up work with student who missed yesterday to "get with another student to make sure you understand."	14D	14D
			1:28	Teacher tells students to "make sure and check internet for 4+1/2 week grade, and to make sure they get their homework done before tomorrow." Teacher states that "some of you aren't using your time wisely very well."	16A	
		END	1:30	Bell. One student stays after to discuss content with teacher.		

03/14/2002	2	T1	0:00	Teacher states that genetic disorder presentations will be done after Spring Break but that the paper is still due next week before spring break.	12B	
			0:05	Announcements are given over intercom. Teacher asks students to be quite and listen to announcements. Teacher encourages the moment of silence and then the students stand and recite the pledge of allegiance with the intercom.	16C	
			0:13	Teacher discusses homework and how the examples were not sex-linked. Teacher states that today's practice is the same as the homework in that it is not sex-linked.		
		A1	0:14	Teacher hands out textbook derived worksheet and asks students to find a partner and get started. Teacher walks around class helping students identify attached and non-attached ear lobes. All students are working in completing worksheet. Male student asks if widow hairline is recessive. Teacher tells students to read introduction. Male student asks if he is to fill it out on himself. Teacher replies "yes." Teacher tells class to write the phenotype you see.	1B 2D 3A 4C 9C 16C	1D 2D 3D 4D
				Male students asks what "the hand thing and widow's peak is." The Research Assistant stands and shows class example of her widow peak. Teacher states that "once you are ready, you can come get a strip of PTC paper and see if you are a taster." Teacher states "look" three times to get class attention. Teacher tell students "to hold paper to tip of tongue and that it will be really obvious if you are a PTC taster."	13B	7C 8D 12D 13C
				Male student asks what a "folding tongue is." Teacher tells student to read explanation on sheet. Teacher shows student how to observe bent pinky (little finger). Two female students discuss chewing on the PTC paper.		

			0:30	Teacher states "time out and look up here." Pedigrees do not mark carriers. Teacher asks "How would you know carriers … if the children exhibit the trait, what do you know about the parents?"		
			0:41	Two male students are finished. Female explains to male students how to read pedigree roman and Arabic numbers. Teacher reminds class they are not sex-linked traits. Female and male students discuss whether one parent is a carrier or not by looking at children. Researcher asked students if they were able to choose the genetic disorder they were researching and one male student replied that they were given a disorder but could change to an alternative if they so chose.	14C	14D
				Male student asks if they have to do computer activity. Student wants to know from teacher if they have a better grade.		
			0:50	Teacher asks students to turn in homework and the sheet they just completed into the inbox on wall. Each student turns in papers to the box when done. Male student enters class late and teacher explains missed class assignment.		
		T2	1:22	Teacher asks for students to return to seats and move desks back to rows. Teacher explains that students are going to take notes.		
		A2	1:24	Teacher turns off lights and begins Power Point presentation on computer displayed on white board. All students take notes on paper on desk. Teacher refers to sample blood type problems they did before. Teacher asks "how incomplete dominance is different from complete dominance." Female student responds that with incomplete dominance, there is a middle. Teacher repeats student answer for class to hear. Teacher discusses multiple alleles and blood typing from power point. Male student asks about negative factor. Teacher states that means Rhesus factor for negative or positive.	1B 8C	1B

				Male student asks if someone can't accept other types of blood. Teacher asks the students if they have heard of the Rh factor and then explains how to write type A, B, O and AB blood as a superscript to the capital letter "I." Teacher uses white board and students respond that they can't see it. Teacher calls on nonvolunteers during power point presentation to answer questions.	3A	3A 4A
				Student sharpens pencil without needing teacher permission. Teacher discusses how antigens attack and how that relates to your body infected by cold/flu. Teacher also relates antigen attack with organ transplants and rejections.	2C	2C
				Male student asks what serum is. Teacher responds with the "other part of the blood." Male student asks if "blood is really blue." Teacher responds "is it?" Female student states that "no, it's not really blue." Teacher asks "do you have blue blood?" Male student asks "at what time?" Teacher states "I will grant 5 extra credit points for whomever brings in a documented answer ... only the first one." Teacher states that tomorrow she will give out a sheet and for students to look in notebook for a sheet titled "Crossing 2 traits" Teacher states "now back to blood types." Female student asks if they have to write this down. Teacher states "it is up to you, but you better know what is going on by looking at it."	7D 11C 13D	7C 8C 13B 14A 15C
		T3/A3	1:20	Teacher states "that is it for notes, but don't put that stuff away." Teacher hands out textbook derived sheet and asks if there are any questions. Two students hands go up in the air. Teacher responds after 1 minute of putting up power point equipment. All but one student works on completing sheet.	16C	7C 8C 12D 14C
		END	1:30	Bell		

				OVERALL COMBINED LESSON CODES	5C/D 6C 9D 10B 11C 12B 14C 17C 18D 19D 20C 21A 22A	5D 6C 9C 10B 11C 14C 15C 16C 17C 18B 19D 20D 21A 22A

Nancy's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
02/11/2002	1	T1	0:00	Teacher takes roll silently/Announcements over intercom/Pledge of Allegiance - Teacher announces for students to water plants in lab - Teacher informs students about camera in room	4C	
		A1	0:07	Teacher asks students to help label cell diagram on overhead. Two students go to overhead projector individually and label cell membrane and vacuole. Teacher completes the remaining organelles with assistance from students' verbal responses. Teacher uses analogies between cell organelles and city constructs.	1C 2D 3A 7C 8A 16C	1C 2D 3A 4A 5D 6D 7C 8C 13A 14D 15A
		T2	0:19	Teacher turns off overhead and erases material. Teacher disseminates 2 instruction sheets. Teacher asks students to be creative and colorful with the model construction. Teacher reads directions from typed sheet "Hanging Out with Cell Models," shows students where materials are located, and states the time for activity. (45 minutes)	16B	

		A2	0:30	Students retrieve materials from desk at the front of the classroom and begin to individually label and construct a 3-D cell model. All but 2 students begin immediately. Students go in pairs to table to use hot-glue guns. All students work on project except one who is sleeping. Teacher monitors room encouraging student ideas, assisting with materials, giving positive reinforcement and feedback.	1D 2C 3C 12C 15B 16D 18D	1C 2D 3D 7D 8E 12D 13A 14D 15A
		T3	1:13	Teacher requests students clean up projects. Teacher hands a large plastic Ziploc baggy to each student for their project. Teacher retrieves a large box for students to place their baggy.	1C 2D 3A 7C 8A 16C	
		A3	1:18	Teacher asks students questions verbally about cell organelle location, function and appearance.	1B	1C 2D 3A 7C 8C 12A 13A 14D 15A
		T4	1:23	Teacher instructs students to turn around and tell the person behind them all they learned today. Approximately 4 students had no one behind them.	14C	
		END	1:30	Bell		
02/12/2002	2	T1	0:00	Teacher erases board and writes new agenda; Announcements over intercom; moment of silence; pledge of allegiance.		

		A1	0:01	Students have picked up their projects from box from previous day and began working them without any teacher instruction. Teacher assists two students with beginning their project because they were absent yesterday.	1D 2C 3C 12C 15B 16D 18D 19D	1C 2D 3D 7D 8E 12D 13A 14D 15A
			0:09	Teacher states she will allow 5 more class minutes for students to finish projects. All students are working on finishing cell model projects. Teacher monitors room asking students questions about their project and giving positive feedback and reinforcement. Students label 3-D cell models with each organelle identity. Students complete worksheet, which asks for organelle function. Two students help teacher hang one model above teacher's desk.	12B 14C 22C	
			0:26	Teacher announces that in 5 to 6 minutes everyone should be completed with their project.	20C	
			0:37	Teacher walks around room asking students to identify their chosen representation of each organelle. She asks students about the function of each organelle as they identify it.	7C 8C	
		T2	0:41	Teacher asks students to put materials away and turn in completed projects and worksheet. Teacher moves overhead cart to front of room and pulls down screen for notes. Instructs students that "they might want to write this down."	12A 16C	

		A2	0:44	Teacher asks students questions about the differences between plant and animal cells. Students verbally respond and teacher writes responses on board. Teacher writes additional information not provided by students. Approximately 5 out of 13 students with worksheet on desk following teacher's instruction.	1B 2A 3A 16A	1C 2C 3A 5C 6C 7C 8C 9D 10C 11C 13A 14A 15A
		T3	0:53	Teacher cuts off overhead and moves it away and shows students a completed "folded fan model" of the plant and animal the students are going to construct. Teacher disseminates 2 woksheets and tells students they may use the completed model or book as their guide. Teacher states that cell drawings need to be large and colorful. 4 students out of 13 have head on desk.		
		A3	0:59	Students begin activity by drawing cell on white paper - 7 out of 13 students with textbook on desk. Teacher monitors room asking students to participate and gives one student a choice to either draw the cell or do a worksheet. The student chooses to draw.	1A 2A 3A 14B 20D	1B 2C 3A 5C 6C 7C 8C 9D 10C 12C 13B

						14D 15A 17B
			1:05	Female student makes earrings and bracelet out of beads and wire and wears them. Teacher gets markers for male student to encourage him to keep working and color his drawings.		
			1:15	11 out of 13 students are working on drawing animal and plant cells	16C	
			1:24	4 out of 13 students go into lab to water their plants and observe growth.	4C 19E	
		T4	1:27	Teacher asks students to have a seat	16C	
		A4	1:27	All students seated. Teacher asks by verbal Q & A method the students about the differences between plant and animal cells. Teacher builds on student responses. Teacher refers to animal poster on wall and states she will put up a plant poster tomorrow.	1B 2C 3A 7D 8D 21D	1C 2C 3A 4A 5C
		END	1:30	Bell		
				OVERALL COMBINED LESSON CODES	4A 5C/D 6D 9D 10D 11C 13B 17D	9D 10E 11C 16C 17C 18C 19D 20B/C 21D 22C

Nathan's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
01/24/2002	1	T1	0:00	Student Roll/Agenda Glance	16C	
				Teacher asked Nature vs. Nurture question regarding yesterday's video		
		A1	0:13	Trade and Grade Procedure		
				Teacher asks students to trade papers and monitors the classroom to ensure the trade. The teacher reads the questions from the worksheet completed on 1/23/02. Students raise their hands and the teacher calls on the student to give answer. The teacher tells the student whether the answer is right or wrong and occasionally asks another student to answer. Teacher explains to students how to give the correct numerical value for items missed.	1A 2A 3A 8A 12A 14A 16C	1A 2A 3A 4A 7C 8A 13A 15A
		T2	0:22	Teacher collects student papers. Student asks teacher to sharpen pencil. Teacher says to wait until later.	19B	
		A2	0:23	Teacher asks questions from assigned reading. Teacher asks questions regarding development stages, birth, and afterbirth.	1A 2A 3A 8A 11B 13C 16C	1A 2C 3A 4A 7C 8A 13B 15A
		T3	0:31	Teacher disseminates quiz paper		
		A3	0:32	All students complete quiz without the use of book, notes, or each other.	9B	13A
		T4	0:42	Teacher stated students are finished with Chapter 6 and they begin mitosis.		

		A4	0:44	Teacher begins by asking students why mitosis is important and then shows DVD clips and reads DVD captions from book.	1A 2A 3A 14A	1A 2C 3A 4A 7A 8A 13A 15A
		T5	0:54	Teacher utilizes whiteboard to refer to drawn chromosomes	19B	
			0:58	Students begin packing materials away		
		END	0:59	Bell		
01/25/2002	2	T1	0:00	Student Roll/Agenda Glance and Opener concerning Embryo Adoption and Update Table of Contents		
		A1	0:08	Teacher performs Question/Answer Method by asking for correct answers to mitosis/meiosis DVD worksheets. Students raise their hands and the teacher calls on the student to give answer. The teacher tells the student whether the answer is right or wrong and occasionally asks another student to answer. Teacher shows more DVD clips and calls on some nonvolunteers. Video clips are approximately 20 seconds in length.	1A 2A 3A 7B 8A 14A 16C	1A 2C 3A 4A 5A 6A 7C
		T2/A2	0:40	Teacher hands out worksheet and asks students to complete remaining questions on worksheet for homework; Students work on completing worksheet	1A 2A 3A 13B	8A 9C 10C 11C 13C 14A 15C
		T3	0:47	Students begin packing materials away		

		END	0:50	Bell		
01/28/2002	3	T1	0:00	Student Roll/Agenda Glance and students retrieve video worksheet from folder	16C	
		A1	0:06	Teacher asks class "What is meiosis?" and begins with question #15 on Video Worksheet. The teacher reads the questions from the worksheet completed on 1/24/02. Students raise their hands and the teacher calls on the student to give answer. The teacher tells the student whether the answer is right or wrong and occasionally asks another student to answer.	1A 2C 3A 8A 13B	1A 2C 3A 4A 5A 6A 7C 8A 13A
		T2	0:25	Teacher asks students to open book to page 192 and note chromosome number of various living organisms after mitosis and meiosis.	16C	
		A2	0:26	Teacher asks for student volunteer to read section from book about mules, horses and donkeys and why mules cannot reproduce. Teacher responds to student questions about mule and dog breeding.	1A 2A 3A 7B 15C	1A 2C 3A 4A 5A 6A 7C 8C 10C 11C 13C
		T3	0:34	Teacher disseminates worksheet for students to complete for homework		

		A3	0:35	Students complete worksheet individually while teacher monitors room and answers questions	1A 2A 3A 7B 8A	1A 2C 3A 4A 5A 6A 7C 8A 13A
		T4	0:42	Teacher assigns reading for homework and asks for students to bring colored pencils tomorrow		
		END	0:42	Bell		
				OVERALL COMBINED LESSON CODES	4A 5A 6A 10B 13B 14A 17A 18A 20A 21D 22B	4A 5A 6A 9C 10C 11C 12B 14A 16C 17A 18C 19B 20A 21E 22B

Delaine's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
03/13/2002	1	T1	0:00	Bell sounds - All students take seat. Teacher states "turn in enrichment papers to the box and posters to me." Guys listen up. (x2) There were six examples of dihybrid crosses from yesterday. Teacher states "by the show of hands, does anyone need more help?" More than 10 students raise hand. Teacher selects randomly six students to put problems on board. Teacher says to use both white boards and to space out so each will have room and not to draw their square very large.		4D
				During announcements researcher takes note of student subject posters. They include Rainforest, temperate forest, mitotic cells, Canagvan Disorder, Palau Syndrome, Butterfly Life cycle, Animal/Plant cell, Tundra, Medical Epidemiology, Taiga, Tropical Rain Forrest, Golgi Apparatus - Student constructed models included DNA double helix, clay cell, and virus.	22E	22D
				Teacher academic posters include digestive system, fingerprints and society, Smokey Mountain typology, biotech universe and decorative posters such as wolves, penguins and various bears. Some examples of bones, tusks, and turtle shells are laying available on back table.	21E	21E

				Five students go to board and remaining 16 socialize. One student that was asked to go to board could not as he didn't do homework. Teacher asks another student to go to board. Teacher asks seated students to "check board to look for mistakes." Teacher asks student to put math away. Teacher goes around room and checks students' papers asking "do you have all yours?" Two male students reply "no" and one student replies "I am confused." Teacher helps confused student.		12C 16D
		A1	0:10	Teacher asks class to look at each problem and goes through each of the six problems asking "if the genotype of the parents is correct, if the gametes are correct, and if the cross is correct." Teacher states to notice trends and patterns. One male student replies that phenotype would be "50% brown and 50% running." Another student remarks "that is impossible." They would be "1:1 running black and running brown."	1B 2C 3A	7D 8D
				Teacher asks class "if 12:4 could be simplified?" Students respond "yes 3:1." Teacher points out that heterozygous for both parents and both traits yields 9:3:3:1 ratio always and that it was on the Gateway. Teacher tells students to put sheet in notebook. Male student asks if they could have a sheet "with everything in order in their notebook?" Teacher responds that would be a big sheet.		13C 14C 15D
		T2	0:20	Teacher tells student to get out a piece of paper, pen & pencil. Teacher states "listen up" twice. Male student replies "I hate notes Augh." Teacher state "listen up." Teacher states that "this is the third time I have called you down - get out a piece of paper and pen doesn't mean have a giant conversation. I will have the "promised assigned seats" for you tomorrow."	20B	

		A2	0:22	Teacher tells students to include a pedigree on their genetic disease paper/presentation if they find one on the internet. Teacher begins power point presentation. All students take notes. Teacher explains the Y or X sperm fertilizes the egg determining the sex of the baby. Male determines sex as of now, but on a Discovery show, they showed research being done on the egg. Researchers believe a presumed chemical providing a chemical coating on the egg could deter the Y sperm from mating.	1C 2C 3C 4C	1C 2C 3C 4C
				Teacher discusses genetic diseases and asks if possible for females to have one X. Female student says "yes if they had Turner's syndrome." Teacher asks if someone could live with just one Y. Male student says "no." Teacher states Turners, Edwards, Downs and Klinefelter all result in the wrong number. Teacher refers to student that will tell them more about XXY next week.	7C 8B 12D	7C 8D
				Teacher goes through power point and answers female student question of "when sperm are produced, sperm with only X carry disease." Teacher responds "exactly." Female student asks if there are sex-linked on Y. Teacher states "very few except those that code for maleness." Female student asks "why?" Teacher states that the Y is smaller.	13C 15C	13C 14A 15C 16C
				Male student asks "if a male has a sex-linked trait, will it show up every time?" Teacher responds "yes." Female student then adds "but if a female has it, she might be a carrier." Teacher gives examples of sex-linked inherited traits - color blindness and Muscular Dystrophy. Teacher states the male can only pass to daughter.	13C	

				Teacher points out poster on wall in room, which has very small print but lists the mapped genes on each chromosome.	17C	
				Teacher explains Barr bodies and inactivation of on of the X chromosomes. Teacher states one inactivates so the X's aren't competing. Teacher states there is current research on this with fruit flies. The paternal or maternal is randomly inactivated.		
				Male students asks "how the X Barr body goes through Meiosis?" Teacher states that the inactivated Barr body is reactivated before meiosis. Male student asks if "reports are due Wednesday."	13D	
				Teacher states "listen up." Teacher asks students not to draw but to pay attention and listen up to explanation of diagram on power point. Teacher asks student to hold question until finished with explanation. Female student asks "if genetic counselors can tell things like that?" Teacher responds that they can tell with the use of pedigrees sometimes. Teacher explains another diagram of a red/white eyed fly cross. Male student in back row looking at personal photographs.	13D 14A	
				Teacher points out the word hemizygous on the power point diagram and asked "what hemisphere means?" Students respond with "half." Teacher says "right" and give definition of Hemizygous. Teacher asks students if they "see how this works."		
		T3	0:51	Teacher states the class will do an activity with sex-linked inheritance. Teacher hands out Gateway generated worksheet and asks students to look at pedigree and use their notes, vocabulary, and book. Teacher reads the problem statement from the worksheet and states that the worksheet setup is an		

				"inquiry-based experiment."		
				Teacher reads the Key and tells the students to note the lower case if used for recessive. Teacher states the students are to figure from pedigree the genotype for each for Q.1. Teacher explains horizontal lines as marriage and vertical lines as offspring.		
				Teacher states that students can work "2 per group, no more, if they want." Teacher states that the students "better be working." Teacher walks around room as students move chairs to work with others.		12D 14D
		A3	0:55	Male student asks if "I am doing this right." Teacher states "yeah." Male student asks "if chance is percentage." Teacher responds "yes." Students discuss sheets in groups. There are 4 groups of two students and 2 groups of three students and 1 group of five students. One female student works individually.	1C 2C 3A 13B	1C 2D 3C 13C
				Teacher walks around room saying "I am just looking; you answers look right." Female student says to teacher "I actually get this; this class is so hard." All students work on completing worksheet.	9C 16C	4C 7C 8C
		T4	1:05	Teacher states for class to "listen up" twice. Teacher asks them to "get back in their seats and straighten desks" twice.		16C
		A4	1:06	Teacher states she has a "couple more little notes and then we will look at an odd pedigree where a guy is his own grandfather."		

				Teacher states that a "pedigree is a family tree in a nutshell." Teacher states "you can find your genetic history from carriers in your family." Teacher states "going to new doctor as example of when one has to complete a checklist on their family for a family history."	1C 2C 3A	1C 2C 3C
				Female student asks "if you and husband could have your father?" Teacher states "you will see." Teacher asks students to practice shorthand in taking notes. Teacher states that "the power point is just a written description of what they just did." Teacher explains how to simplify typed slide into just a few words. Female student remarks that "sometimes it takes just as long to translate it."	14A	7C 8C 13B
				Two student during notes get up and get tissue to blow nose without needing teacher permission.		14A 15A 16C
		T5	1:17	Teacher hands out sheet with song and reads song and then tells students to create pedigree of song. Teacher states that "you obviously cannot do a straight linear pedigree and you will have curved lines." Teacher states that students may work in groups of two and they are to finish for homework tomorrow.	3A	
		A5	1:20	Male student asks "if he can do it on the back of this sheet?" Students move chairs and form same groups as before but change location . Two female groups move to long tables to have more room. Student who worked individually before joins group. All students work in groups to construct pedigree.	1B/C 2C 3C	2D 4C 12D 14D
			1:25	Male student raises paper that he "got it." Female student states in group "hallelujah, I understand." Male student asks teacher "if you can marry yourself." Teacher states "no."		7C 8C 13A

		END	1:50	Bell. Students stay after working. Half of the class continues working on pedigree after bell. Male students who "got it" asks teacher is his is right. Female student asks teacher about her genetic disease report.		16C
03/14/2002		T1	0:00	Bell rings. Students are seated. Teacher is in front of room with new assigned seating chart "as promised."	20B	
			0:01	Teacher reads students' names and points to desk where student is to sit for the remaining of the year. Students relocate to new seat according to teacher direction. Teacher states "that seats will be this way unless something else happens ....If behavior continues on an individual level, you will be seated at the office." You will learn "to keep your mouths shut."		
				Female student asks if they get another day for their genetics report as first period did. Teacher replies, "no, they aren't getting another day either."	20B	
				Teacher tells students "to get with a partner and help each other out to see what trait you are." Teacher states that "once you get the phenotype, you can try to determine the genotype, and you might think of your parents." Teacher says that after Spring Break, they will use the genetics while looking at an organism and observing different traits. They will use fungus to apply genetics. Teacher states that "once the students have mastered that, we will go to DNA fingerprinting."	4C	4D

				Teacher shows class PTC paper and explains how some people are classified as "super tasters with extra sensitive tasting abilities." Teacher discusses three-hour Discovery television show about the tongue and discusses how her neighbor gets paid $125,000 a year to be a taster for a candy company. Students ask if teacher watched all three hours of show. Teacher responded "yes, the tongue is really fascinating." Students laugh and teacher replies "it is." Female student responds, "is that why our fungus labs aren't graded?"		
		A1	0:15	Teacher instructs students to remove gum and gives each a piece of PTC paper to test if they are tasters. Teacher hands out textbook-derived worksheet and students begin tasting and working on worksheet.	1B 2D 3A	1D 2D 3D
				Female student tells teacher "I have done this before and I couldn't taste it and I thought it tasted nasty." Teacher did not respond.		4D
				Teacher walks around room pointing out students' ears as examples of attached and nonattached ear lobes. Male student asks if you do the worksheet on yourself. Teacher replies "yeah." There are 10 groups of two students each, with 8 groups being same sex partners. All students are engaged in completing worksheet.	9C 16C	7C 8C 15C 16C
			0:22	One female student asks another female student "if they are doing this for ourselves." Between-group conversations about content are frequent. Male student asks teacher "what is folding?" Teacher refers to another female student who demonstrates to class what a folded tongue looks like.	13B	12D 13C 14D

		T2	0:50	Teacher asks students to return to assigned seats. Teacher states the notes will be co-dominance with multiple alleles. Teacher states the uses and importance of blood typing with organ donation, blood transfusions and parental inheritance matching.		
		A2	0:52	All students take notes from Power point presentation on white board. Teacher asked student to put something away and he responded by putting it away. Teacher asked students if they remembered polysaccharides. Students stated "sugars." Teacher asked "what red blood cells are used for?" Students respond "to carry oxygen." Teacher asks what happens when you perform heavy exercises. Students say you need more oxygen and you build up lactic acid. Teacher states "right." Teacher discusses how increased red blood cells will compensate at high altitudes and help avoid cramping - that is why the Olympic athletes trained at Colorado, which is at a high altitude. Male student says increased oxygen will mean less cramps. Teacher agrees by saying more oxygen will decrease chance of cramps. Teacher states that it takes 3 to 4 days for the body to compensate for higher altitudes.	1C 3A 8D 14A	1C 2C 3C 4C
				Teacher moves from red blood cell discussion to blood typing. Teacher reads power point slide of co-dominance and how it is expressed in the human form. Teacher discusses antigens and antibodies and four different blood types, A,B,AB, & O.		13C 15C
			1:03	Male student raises hand - teacher continues discussion of blood types. Teacher does not respond to raised hand.	11A	

				Teacher discusses chart with student about blood types and the differing antigens found in each. Teacher states that "antibodies fight off foreign bodies .... If someone is sick with the cold or flu, they are said to increase their immune system which means antibodies build up." A memory system exists. Teacher uses chicken pox as an example because once you have had it, you cannot be reinfected because of built-up antibodies.	2C	
			1:05	Female student raises hand - then puts hand down without teacher response. Teacher explains that Type 0 is Universal Donor and Type AB is Universal Recipient. Male student remarks that Type O can only have Type O. Female student says "I am clear on everything but what they are."	11A	
				Teacher states an "antigen is a red flag that says destroy me." Antibodies attach to antigen. Teacher asks class "what can happen if blood clumps together?" Students respond "blood clot." Teacher asks "what can a blood clot do? Does it move?" Students respond that "you can die." Teacher asks "what if it is in your brain?" Male student responds it is an aneurysm. Teacher tells class that when she was in high school, they did a blood lab with real blood and they mixed A and B and the result was a gelatinous material. Teacher states they cannot do that now for obvious reasons.	2C 8C	7C 8D
				Female student asks about negative and positive aspect of blood. Student asks "if they have to write this down?" Teacher states "no it is in the book."	13B	14A 16C
				Teacher states the students should have the universal donor and recipient down if didn't from earlier. Female student asks if a person with O blood and no antigens, they would be more susceptible to disease. Teacher states that the antigens are only	13D	

				for A & B. Teacher asks if there are any questions. Students are silent.		
		T3/A3	1:22	Teacher turns lights on and passes out textbook-derived worksheet for homework. Teacher states "these are more examples of crosses and "you will lose points in failure to use correct genotypes." Female student asks if it is homework. Teacher replies "if you don't finish." Teacher has students to look at first problem and reads first problem. Teacher asks students to work quietly with neighbor and not someone that is across the room. All students work on completing worksheet.	1B 2A 3A	7C 8C 13A 14D 16C
		END	1:30	Bell	5D 6C 9C 10B 11A 13C/D 14A 17C 18D 19C 20B 21E 22E	4C 5D 6C 9C 10B 11C 12D 13C 14C 15C 16C 17C 18D 19B 21E 22D
				OVERALL COMBINED LESSON CODES		

Lucy's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
03/07/2002	1	T1	0:00	Announcements are on intercom. Teacher is passing out papers. Asks students to put graded by and their name. Teacher states that today they will be doing the roller coaster lab. Teacher asks student to be quiet. Teachers states that extra credit Rube Goldberg projects are due tomorrow. Teacher tells class they did the best of her classes on yesterday's midterm, which is scantron graded. Teacher tells class they will wait for student to return to class before giving answers. 15 Students - 8 males and 7 females	9A	
		A1	0:03	Teacher asks students to "be quiet." She states "let's grade this." The worksheet is word game that was assigned after the midterm on the previous day. The worksheet content was not science related. Teacher reads answers and students grade. Students ask if "they put this, would you accept it?" "How about this?" "Can we take this?" Teacher responds with yes or no. Teacher stated that she "never figured number 14 out." Teacher asks students to "count how many are missed and put at top of paper and to pass it in." Teacher states that students may "tell them (the student) what they got."	8A 10A 11A 13B 18B	7B 8B 12A 13B 14A 16C
		T2	0:10	Teacher asks students to "split up" and tells students they will use a single BB, aquarium tubing and tape. There are six groups of two and 1 group of three. Male students grouped with males and females with females.		

		A2	0:12	Teacher tells the students that this is open-ended and it something they have never done before in her class. Teacher says they are to build a roller coaster with the tubing as the track and the BB must stop within an inch (tubing is marked with black line) of the end of the tubing without rolling out or rolling back up the tubing.		5E 6D 7B 8A 11A 12E 13A 14E 15A 16D
				Teacher states that tomorrow the students "will have certain rules to follow and they will have to factor in gravity, speed, acceleration, centripetal forces and things like that." Students asks if it can roll backwards. Teacher states that she has "to watch it go for it to count." Teacher states that they will get only one BB, and because of the schools zero tolerance, they will not get another one if lost. Teacher also stated for students not to blow in tubing for two reasons 1) condensation will occur in the tubing causing erroneous results, and 2) the tubing was dirty as it was stored in a bag with a dead roach.	19A	
				Teacher gives each student group tubing, a single BB, and masking tape. Students begin to work on building roller coaster. Teacher states that tomorrow, students will have to drop the BB the distance "as high as this table." All students are seated on the floor and engaged in building coaster Teacher walks around each group of students and asks "How it is going down there?" Student to student discussion includes: this is too fast so lets raise this a bit; Oh I raised it too much; I like our little spiral setup; I had it working; oh, we got it; can't do it again; Mrs. ____, you are making me frustrated. Augh.	7A 8A 9A 10A 14C 16D 18C	

				Students use a variety of personal and classroom materials such as makeup, textbooks, pencils, chair legs, table legs, classroom walls, and table tops.		
				Two students lose BB and literally jump to catch the rolling BB.		
			1:00	Two female students had it working and need to repeat for teacher to see. Students repeated for teacher to see and spend rest of period constructing more designs of coaster.		
			1:10	Teacher suggests that students get ruler and start to make measurements. Male student in group states "we had better do that." Teacher retrieves rulers from supply cabinet for students and each group retrieves one. Three male students make sketch on paper of coaster design unsolicited by teacher.	12C	
			1:15	Two students in one group have lost BB. Teacher states the best way to find it "is to get down on ground and look eye level at floor." Two male students in another group ask teacher for recommendations on how to better their coaster, teacher does not respond. Male students states "well she said it was a student-only project."	16D	
			.	Teacher states that students have one minute left. Male students explains to group "that she means one minute left until we have to clean up."		
		T3	1:20	Teacher states to clean up by "removing tape and placing in trash can and turn everything into me." One group of girls sates "we are going to fail this" to each other.		
			1:22	All students are seated and materials are returned.	16C	

		A3	1:23	Teacher begins to talk but states "I am waiting on you; I am not talking over you." Teacher explains that the extra credit project (Rube Goldberg) is due tomorrow. "Bring it tomorrow or it is too bad; tomorrow is the end of the grading period." Teacher tells student to stop tapping feat. Student stops. Female student asks if the midterm grade will be on there? Teacher responds "yes." Teacher asks if there are any questions. Students have no response.	7A 10A 13A	11A 12A 13A 14A 15A 16C
			1:27	Teacher states "we have 3 minutes so stay in seat and push chairs in when you leave" Teacher asks students to "look at floor and clean up area" Announcements are on intercom. Teacher is sitting at desk and students socialize.		
		END	1:30	Bell		
03/08/2002	2			Teacher writes homework assignment and Rube Goldberg extra credit reminder on board before class. Teacher leaves room and then two male students play with Slime toy and put it away when teacher re-enters room.		
		T1	0:00	Teacher asks for student volunteer to go to office with attendance. Female immediately volunteers. Announcements are on intercom and ask for everyone to observe a moment of silence. All students and teacher observe moment in silence. Phone rings and teacher answers. Students socialize with each other. Teacher states there is new student and that "I haven't met him, but I am sure he is nice."		
				When female returns from office, teacher says "go to Ms. Davis' room; she needs for you to do her a favor."		
		A1	0:05	Teacher hands worksheet to each student. Teacher states "listen" twice and then "be quiet." Teacher tells male student "don't make me give you detention before baseball." Student replies "I"ll shut up then." Teacher replies "good idea." Teacher reads worksheet verbatim and explains what a loop and spiral look like with hand motions.		13B 14A 15A 16C

				Teacher tell students to "get out a sheet of notebook paper." Female student asks if "this is one per group?" Teacher replies "huh, no, one per person." All students retrieve paper and all students write from board information on their piece of paper. Teacher writes on the board while telling the students to "fill out their sheet this way." Items such as "your name, partner's name, Name of Coaster, 1. BB stopped __________, 2. Loops _______ Spirals 3. Participation." Teacher tells class to "listen; points will be taken off for not listening." Teacher states that everyone will turn this in. Female student asks for the day's date. Teacher responds "the eighth."		
				Teacher explains the grading which is typed on the sheet. Five points for naming the coaster and thirty points for participation. Teacher states that "if you are as good as you were yesterday, then you will get thirty points. If I have to get on to you, I will take points." Twenty points are awarded for BB stopping within an inch.	9B	
				Teacher explains that she wants a "whole page explaining how roller coaster deals with friction, potential energy, kinetic energy, speed, momentum, gravity, friction and centripetal force. Teacher states "I will check off each term, and you will lose points if each is not discussed." Teacher states that the class "will quit thirty minutes early so each team will get three trials to get it" Teacher states that "there is a backup that the loops and spirals can give you points," if you don't get the BB to stop within an inch of the end of the tubing.	10B 12D 16A	
		T2	0:11	Teacher asks if any student brought in the extra credit Rube Goldberg. No student responds. All students go to same area of classroom as yesterday to begin working. Teacher hands out aquarium tubing, BB and tape. Two male students accuse two female saying "hey, you stole our idea."		

		A2	0:13	All students are engaged in designing coaster. Teacher states that out of her two classes yesterday, "three groups got it to work - two female groups and one male group." One group lost BB and is looking for it. Teacher repeated the best way to find it as yesterday. Teacher monitors class by walking through looking at students constructions.		5E 6D 7B 8B 12E 13A 14E 15A 16D
			0:20	Two students looking for BB, and then teacher asks "everyone to stop and help [them] find BB. Two male students reply that "they didn't help us find ours yesterday." Female student gets up and looks around room saying "it aint in the back of the room" then she exclaims "I found it!" Female student states she should get extra credit. Teacher replies "keep dreaming."		
				Students claim their coaster is "shady." Teacher asks if that is a word. Students ask teacher "if we put loops as it is going down first hill, does it count?" Teacher replies "nope." One male group states "they can't get theirs to go around loop," and another female group helps by saying "watch" and shows them how. Students use a variety of personal items in their coaster including: a Tiki charm for good luck brought from home, suckers, lip gloss, bottles of lotion, pens, Tootsie Roll container.	14B 16B	
				Student discussion within groups include: "let's make this go up with the lip gloss," "we need lucky tape on the end," "we need another book actually," "No, that won't make it," "it will pick up too much speed here."	14B 16B	
			0:40	One group said it stopped right on line. Teacher goes over and states "I have to witness it." Group repeats successfully.		

			0:45	Teacher states that the groups "have twenty minutes left." Female student responds "yeah right, like we can do that." Female student tells her group we need more loops and spirals. Male students tells his partner they "need loops and spirals - tons and tons of loops and spirals." Teacher asks student to put Slime toy away. Student puts toy away. Female students are adjusting coaster by moving 5 pens under tubing to various points. Male student asks teacher for more tape.	20A	
			0:56	Teacher says "how about 7 minutes guys and make sure you have made your roller coaster within 7 minutes." Female student says to group that they are naming their coaster "pumpkin." Another female student from group says how about "the mini beast that don't work." Another female student suggests "sugar daddy" as a name. Students laugh.		
		T3	1:05	Teacher states that "time is up. Bring paper, and BB up here now." Phone rings. Teacher states "if you aren't up here in 10 seconds, you lose 5 points." Students quickly go to front of room.	20A	
		A3	1:08	Teacher asks for everyone "to listen, and don't lean on tables and that everyone will have three chances." The first group's BB was stuck and a student blew into the tube." Another student said "you are not allowed to blow in it, because of precipitation." Other students chime in "condensation." Teacher tells all "to pay attention or points will be taken off." Teacher states again "guys, you are going to lose points if you don't get over here and pay attention." All students watch all three trials by each group. One group out seven was successful in getting the BB to stop within one inch of the tubing end. Students jokingly call that group "cheater" while laughing.	20A	5E 6D 7B 8B 12E 13A 14E 15A 16C
		T4	1:17	Teacher instructs students to clean up materials. Teacher states "if I find tape in your area, I will take points off your participation." Teacher tells groups to take a seat and start working on homework (written on board)	20A	

			1:22	Teacher states that homework is on board and to "make sure chairs are back where they go." Chapter 8 Vocabulary and the essay part of this lab is their homework due Tuesday. Monday is in-service for teachers. Teacher states "you have eight minutes to work on this, so work." All students are seated.	20A	
			1:23	Teacher goes to back of classroom and work on computer for approximately two minutes. Six out of fifteen books are open on student desks. Two male students say "potential energy is at the top," "potential energy is at the beginning," "kinetic energy is when it is in motion." Teacher asks for student to bring Slime to her. Teacher takes Slime. Two students are working on homework.	12D 14D 16A	13A 16A
			1:26	All students socialize. Class discusses new student that was suppose to be there. Male student asks "what do we write about the roller coaster?" Another male student says "look at the sheet." Teacher reads schedule of new student to class. Female student responds "he is smart."	14B 16B	
		END	1:30	Bell. Teacher returns Slime to student with warning that she will keep it next time.	16C	
				OVERALL COMBINED LESSON CODES	5D 6B 9B 10A 14B 15A 17B 18B/C 19F 20A 21B 22A	9C 10B 11A 17B 18C 19F 20A 21B 22A

Eileen's *STAM* Record

DATE	TAPE	A or T	START TIME	DESCRIPTION	PI STAM	AST. STAM
03/21/2002	1	T1	0:00	Teacher gives each student a worksheet constructed by the teacher title "Fungi Observations"		
				Student constructed posters (4) subjects - simple machine, rainforest, radiation and shower pulley apple shaker Teacher posters - periodic table, medical breakthroughs, metric system, Tennessee Valley Authority treasures (fish), Wildlife of TN (fish), solar system, classification, sharks, reptiles, creepy crawlers, diversity map, tree/leaf classification, migratory land birds Other items: Aquarium with fish, homework board, student class picture, religious crucifix	21E 22D	21B 22E
				Teacher states there are ten unknown samples and three stations (A-C) have been set up for you. Teacher tells students to observe and then write characteristics. Teacher said students are to make blind inferences as to what Fungi type the samples are. These inferences are stated in the form of a hypothesis.		

				Teacher states that for Day 1, there are five objectives Teacher reads objectives from sheet 1. Several stations have been set up for you to observe fungi characteristics. 2. Unknown samples are set up for you to observe the distinguishing characteristics of the main types of fungi. 3. At each station, draw a sketch of the unknown fungi sample as well as list as many characteristics of the sample as possible. Things to look for: shape, color projections from the sample, unique structures, size, etc. *Make sketches and observations on Observation Sheet. 4. The goal for today is to make good sketches of the unknown fungi samples as well as start to gather information about the possible characteristics for the four main types of fungi. 5. Identifying the unknown samples will come on Day 2 of this lab but hypothesize as to what the unknown sample is and the type to which it belongs. Types: Sporangium, Club, Sac, Imperfect	4D 6C	4F
			0:07	Two male students enter classroom and retrieve materials from locker. Teacher does not call attention to students' presence. One of the male students drags and scuffs shoes on carpet walking to locker and out door.		
			0:10	Unknown adult lady present at beginning of class using teacher computer and then leaves classroom.		
				Teacher explains that Day 2 will involve identifying the unknown samples and writing hypothesis on last sheet - "just like in the Protist lab." Teacher asks if there are any questions before starting. Male student raises hand and is verbally acknowledged by teacher. "So we get A, B, and C?" Teacher explains A, B, and C stations again. Male student states "so those are the only ones we do?" Teacher states, "no, you do A-J." Female student asks if "A-C are exactly the same?" Teacher responds that the 2 microscopes for A are the same; however, B & C are different. Male student asks "are they focused?" Teacher responds "yes, you may have to readjust to your eyes." Teacher states the goal is to get sketches and list as many characteristics, and then write a hypothesis.	13B	

		A1	0:12	Teacher states to go ahead and start. All students get up to retrieve microscopes and move to stations.	1D 2D	1F 2E
				Male student says Station A sample "looks like bacon." Teacher repeats "bacon?" and smiles.	3C 11C	3D
			0:13	Teacher states to entire class to "remember characteristics." Male students ask "do we need to color?" While viewing through microscope, male student remarks "that is disgusting." Teacher and two male students negotiate where to set up table near a power outlet.	19D	
			0:15	Female student remarks while looking through microscope "whoa, I see it already."		
				Stations A-C are dissecting scopes with prepared materials. Slide A is molded bread. Station B is a portion of a mushroom. Station C is ?		
				Teacher reminds students to look at all parts of the mount.		
				Female student remarks while looking through microscope "I got it closer so now it is really disgusting." Teacher goes to microscope to view what female student is viewing.	11C	13C
				Teacher asks class "when listing characteristics, is one characteristic acceptable?" Students have no response. Teacher walks around the room answering questions and viewing through microscopes. All students are engaged in observing and drawing.		
				Female student tells another female student "let's go see the bacon." Female student goes to station B. Male student responds "that is the ham, the bacon is over there." (pointing to station A) Male student remarks to teacher "you aren't saying that bacon is fungus are you?" Teacher states "no." Teacher walks over to group of males and puts finger to mouth. Students are quiet and one replies "sorry."	12C 14D	12F

				Female student at station A states "this doesn't look like bacon." Male student responds "well I think it does and what I say goes." Teacher tells students to "drop the discussion on that please." Male student says "ok," and teacher responds "thank you."		
				Teacher asks male student "what do you see?" Male student responds "bread with mold." Teacher states that you "need to sketch it." Male student says he is not an artist. Teacher states "just represent it."	8D	
				Female tells another female student "that looks like the red type things we saw." Male student asks another male student "what are these swirl things?" Male student responds "the sporangia?"	14E	14E
				Students move from microscopes at table to prepared stations A-C arbitrarily. Slides D-J are purchased prepared slides viewed from microscope at students' desks.		
				Male student states "oh that is cool, science is the best." Male student remarks that it "looks like goat cheese." Male student asks teacher if "these have to be a good drawings?" Teacher replies "not perfect." Male student says "ok, that looks pretty bad."		
				Teacher asks student by name to "shh." Male student goes to bin to retrieve color markers and pencils. Female student remarks "this is gross and nasty." Female student asks another student "have you seen this yet because it is the most disgusting thing." Five students at stations A-C and all drawing but one.		
				While helping group with microscope drawings, teacher uses white board to draw a representation. Female student to female student "this looks like cheese."		

				Teacher rests hands on student's shoulders while discussing what the student saw. Female student says it looks like "cheese." Teacher asks if "she touched it and was it jelly-like?" Female student responds "it feels like cheese."	8D	
				Teacher squats down on knees to be at eye level with student and asks "what he saw in number C." Male student responds that it was a "blob." Teacher asks the student to view the station again. Male student remarks that "without the microscope it looks like sawdust, and with the microscope it looks like cheese."	8D	
			0:37	Teacher asks students to "be wrapping up." Teacher asks "who is ready to do hypothesis?" Teacher states that another characteristic to list is if the sample exists in different sections.		
				One male student to another male students states "it looks like a moldy rind."		
				Teacher asks for characteristics to be in scientific terms twice.	7C	
			0:42	Teacher states there is just a "couple of minutes and to wrap up." Male student remarks that Station A cannot be moldy bread; he asks teacher if he is correct. Teacher states to "use the four types I gave you, the four choices."	16D	16C
		T2	0:45	Teacher states that bell is going to ring and to "turn microscopes off and put objective on low and place slides on front table." Teacher asks "when you are done with the lab, turn the light source off."		
			0:46	Teacher states to "list the characteristics in scientific terms and re-evaluate the characteristics." Male student says it is a "purple blob" Teacher states that "purple blob doesn't do anything for me or you." Teacher asks class to note if they can see spores or sporangia. Teacher asks if there are any questions after today and asked if the majority finished. Three to four	10C	

				students raise their hands that they had finished. Teacher states that "we		
				will wrap up observations and do a hypothesis for each observation the next activity."		
				One male student tells teacher he will not be there tomorrow as he is competing in a diving meet to qualify for nationals. Teacher states good luck.		
				Teacher asks students which were easier to determine "the samples A-C that I set up or the samples D-J that were set up for you?" Students respond the "samples you set up."		
		END	0:55	Bell. All microscope lights are off and all slides are on front table.		
03/25/2002	2	T1	0:00	Class did not meet on Friday, March 22 therefore, Monday, March 25 is the next day. Students enter the class and the teacher asks them to "have out their fungi lab please." Teacher states the class will refresh and take a "re-look" from last Thursday at stations A-C and D-J. Female student says she cannot find hers. Teacher hands student one that was left in class but female student says that is not hers. Teacher gives student a new sheet.		
				Teacher points on whiteboard to objectives for the day and reads from sheet the objectives. Students are to do a group general hypothesis and then the 2nd part is identification. Male students asks "so what is the hypothesis - the type?" Teacher states "don't do type today that is 2nd part - finish sketches and list characteristics in scientific terms and on the identification sheet write a hypothesis.		
		A1	0:07	Teacher states that students can move tables wherever and that the power strips are up front. Male students tell female student "we need to look at microscope some more." Teacher asks female student to move as the male students need to use that table. Female student moves. Students retrieve microscopes, power strips, and slides.	1D 2D 3C	1F 2E 3D

				Two male students have a discussion at a table. Student 1- (S1) How do you identify them? S2 Let's get the book. Teacher walks up to table and states students' names. Teacher walks over to male student and places hands on his shoulders to answer student question. S1 How do we know what each group look like? Teacher - respond to the question in scientific terms. S2 Do we find it in the book? Teacher - Why don't you use this (pointing to student head) and this characteristic list? S1 - Is this globby stuff a word? T - No S1 - With sporangium, spore is right there. An additional male student joins the group and teacher leaves. S3 - It is sporangium, it is in the book. S1- You were not suppose to use the book. S1 - For Sample number 5, we put sacs. S3 - but it is sporangium. S2 - it was soft brown spots divided into sections.	13C 14D 16D	4F 13C 14E
				Teacher returns and asks the table of male students to go around and view again and re-assess. S1- Can we do that? T - Yes, Yes, why don't you do that. All three male students go to review different stations. In approximately 1 minute all three male students return.	19D	12F
			0:15	Teacher seated at desk looking through papers with student. All students working on drawing, writing, or observing. One table discusses popular movie while working.		
			0:17	Teacher leaves desk with student and helps group of students focus microscope. Teacher tells student to "look at large section 4x first then narrow." Teacher goes to another table and asks "how are you guys coming along?" Students move freely throughout room getting slides from table and borrowing slides from others.		
				Three male students at table tell teacher "they are having a hard time with H & G. S1 - H has circles and G has rods and that's all we know. T - What might be a scientific word for … S1 - the blue rod! - like Cilia? T - No, no, fungi. Look at the fungi characteristics in your notes.	16D	16C

			0:22	Teacher states that after the characteristics, go on to the hypothesis. S1 - It is kind of like a whippy thing. S2 - What is F? S1 - he has got it. S1 to T - Is this the fungi version of flagellates? S2 to S1 - Why don't you put your notes in the clip thing man? T - picks up book and finds student's notes in book saying "imagine that." T - look at structures and what is that? S1 - Hyphae? S3 - Hyphae isn't everything. S1 - We already know F. S3 - Maybe they are imperfect? S2 - Retrieves G slide from another table to view again and gives to S1. Female student arrives at table and asks for Slide G. S1- gives female student slide. S3 - I think imperfect - let's make a bet on them.	13C 14D 15D	14E 15E
				S1 - blue with hyphae thing? And big group of woolly things. S1 - Not all mushrooms are clubs and not all clubs are mushrooms. Students put up microscopes when finished.		
				S1 to T - what's 7? T - You can put more than one group. S2 to T - Female student is using her book. S1 to Female S - She (teacher) prefers you to use your brain or mind. S3 - she doesn't use her brain S1 - Number 8 is sporangia and club and number 9 has hyphae S3 - J is imperfect also.		
			0:30	Teacher states "I wouldn't have you observe and write characteristics if I let you use your book." You may use your notes on structures.		
				S1 states to teacher "we got all but number 9." S1 to T - it is a rod with … T to S1 - look at that characteristic S1 - It is cup-shaped.		
				Female student to another female student - what is that hyphae called? Teacher points on notes of female student paper.		
		T2	0:37	Fire drill alarm sounds. Students leave single file to front of schoolyard. Teacher takes roll as students line up and respond to their name. Teacher tells student her name and that twelve are present for student to report.		
		END	0:40	Bell. Class is over when students return from outside. Teacher announces for homework to finish hypotheses and repeats twice "no book." Use		

				Structural notes only. Students return all materials.		
03/26/2002	3	T1	0:00	Teacher asks students to "have a seat at your regular seat." Teacher says "you will need your book today and that we are going to do the zigzag method with cooperative groups."		
				Female student says she will need to share a book with someone because she can't return to her locker because another teacher won't like it.		
				Teacher states that the groups are going to look at the 4 types and identify them for sure. Teacher hands out the informational teacher-made worksheet to each student. Teacher repeats that you will need a book for this. Teacher explains that this is in two parts. Teacher states that each group will meet as a group labeled A, B, or C. Teacher has assigned students to groups. Teacher tells students to take notes, and list characteristics of sporangia. Teacher calls students names for Group A and assigns them Sporangia, Group B - Club, and Group C - Sac and Imperfect.		
				Teacher states that students are "to look at the second page of the handout and write the notes from their group on that page for whatever letter you were assigned." T- "that is the zig part of it." T - "draw visuals or diagrams and do a thorough job as you are responsible for teaching or relaying the information to the other group for that type."		
				T - then in the final groups we will have a combination of A, B, and C so that one student of each group will teach the information to the other two students.		
				Male student asks "if the first ABC groups are today and Group 1,2,3 are tomorrow." T- "we will do it today and I will tell you when to mix." Female student asks "do we write the information down?" T - "They will discuss it with you." T - "Any questions?" Teacher assigns Group A to sit at one table, Group B at another table, etc.	13B	13C

		A1	0:10	All students go to assigned tables and take out book and begin to take notes. Teacher walks around to the four tables and answers any questions. There is one group of males, one group of four males, and one group of five, including three females and two males.	1C 3A	1D 2D 3D
				Male student responds that "we are not used to discussing and communicating - this is quite weird."		4D
				Female student complains that one male student in group is "ignoring us all together."		
			0:21	T - "We are going to switch in a couple of minutes." All students are silently copying information from the book for the next 2 minutes.		12E
				Female student asks teacher "what is this supposed to do." Teacher responds "help you identify types from the characteristics." Student asks "can we draw this?" Teacher states "yeah, if you want to."	2C	
		T2	0:21	Teacher states "switch to have a mixture of A, B and C … have a good basis for that type of fungi." Male student asks "just that group of everybody?"	13B	
		A2	0:22	Female student asks male student in group "what are we doing?" In one group, the male student hands over his worksheet to the other two students and they copy the information from the sheet. In other groups, one person reads the information from the sheet as the others copy the information onto their sheet. Teacher tells one group "you can draw there (pointing to whiteboard) to show the group." Teacher draws a piece of bread on the board. Male student responds "awesome." Teacher has space on whiteboard for all groups.		

			0:35	Male student stands at end of table and reads and gives information to his group. Female student from another group reads information while two males students take down what she is saying. Male student from another group reads his notes as the others write down the information. In between reading the notes, this male student completes Spanish homework. Teacher walks by and does not address Spanish homework.		
			0:37	Teacher moves to student-group table and asks male student to put up the Spanish book. Student states that he is talking to his group, as he puts up book.		
			0:38	Teacher asks groups to move to third type. Female student asks if "we should draw the pictures" on the notes.		
			0:44	Teacher states the "bell will ring in a minute."		
		END	0:45	Bell		
				OVERALL COMBINED LESSON CODES	5D 6C 9C 10C 11C 12C 17D 18D 19D 20C	5E 6D 9D 10E 11C 12E 17D 18E 19F 20C

Appendix F

Researcher and Assistant *STAM* Participant Summary Codes

Richard's (T1) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	B	B	+++
2	B/C	C	++*
3	A	A	+++
4	C	C	+++
5	B	C	++
6	C	C	+++
7	C	B	++
8	B	B	+++
9	C	C	+++
10	B	B	+++
11	C	C	+++
12	A	B	++
13	B	A/B	++*
14	B	B	+++
15	B	A	++
16	C	C	+++
17	C	B/C	++*
18	D	D	+++
19	D	B/C	+
20	B	B	+++
21	B	B	+++
22	A	A	+++

* Key to coding symbols
  - +++ - perfect agreement
  - ++ - one level away from perfect agreement
  - + - two levels away from perfect agreement
  - ++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 77% (including categories 2, 13, and 17)
One level away from perfect agreement is 18%
One item that was two levels away from perfect agreement is the remaining 5%

Susan's (T2) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	C	B	++
2	A/B	C	+
3	A	A	+++
4	A	A	+++
5	D	B	+
6	C	B/C	++*
7	B	C	++
8	D	C	++
9	D	C	++
10	C	C	+++
11	C	C	+++
12	D	C	++
13	B	A/B	++*
14	B	B	+++
15	A	A	+++
16	A	A	+++
17	C	B	++
18	C	C	+++
19	C	B	++
20	C	B	++
21	C	B	++
22	A	A	+++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
\+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 50% (including categories 6 and 13)
One level away from perfect agreement is 41%
Two items that were two levels away from perfect agreement are the remaining 9%

Tanya's (T3) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	B	B	+++
2	C	C/D	++*
3	A	A	+++
4	C	B	++
5	C/D	D	++*
6	C	C	+++
7	D	C	++
8	C	C	+
9	D	C	++
10	B	B	+++
11	C	C	+++
12	B	D	+
13	C	C	+++
14	C	C	+++
15	C	C	+++
16	C	C	+++
17	C	C	+++
18	D	D	+++
19	D	B	+
20	C	B	++
21	A	A	+++
22	A	A	+++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
\+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 73% (including categories 2 and 5)
One level away from perfect agreement is 18%
Two items that were two levels away from perfect agreement are the remaining 9%

Nancy's (T4) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	C	C	+++
2	C	C	+++
3	A	B	++
4	A	A	+++
5	C/D	C/D	+++
6	D	C/D	++*
7	C	C	+++
8	C	C	+++
9	D	D	+++
10	D	D	+++
11	C	C	+++
12	B	C	++
13	B	B	+++
14	C	C	+++
15	B	B	+++
16	C	C	+++
17	D	C	++
18	D	C	++
19	D	D	+++
20	D	B/C	+
21	D	D	+++
22	C	C	+++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 77% (including category 6)
One level away from perfect agreement is 18%
One item that was two levels away from perfect agreement is the remaining 5%

Nathan's (T5) *STAM* Codes

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	A	A	+++
2	A	C	+
3	A	A	+++
4	A	A	+++
5	A	A	+++
6	A	A	+++
7	B	C	++
8	A	A	+++
9	B	C	++
10	B	C	++
11	B	C	++
12	A	B	++
13	B	B	+++
14	A	A	+++
15	C	B	++
16	C	C	+++
17	A	A	+++
18	A	C	+
19	B	B	+++
20	A	A	+++
21	D	E	++
22	B	B	+++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 60%
One level away from perfect agreement is 31%
Two items were two levels away from perfect agreement is the remaining 9%

Delaine's (T6) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	B/C	C	++*
2	C	C/D	++*
3	B	C	++
4	C	C	+++
5	D	D	+++
6	C	C	+++
7	C	C	+++
8	C	C	+++
9	C	D	++
10	B	B	+++
11	A	C	+
12	D	D	+++
13	C/D	C	++*
14	A	C	+
15	C	C	+++
16	C	C	+++
17	C	C	+++
18	D	D	+++
19	C	B	++
20	B	B	+++
21	E	E	+++
22	E	D	++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 73% (including categories 1, 2, and 13)
One level away from perfect agreement is 18%
Two items that were two levels away from perfect agreement are the remaining 9%

Lucy's (T7) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	N/A	N/A	N/A
2	N/A	N/A	N/A
3	N/A	N/A	N/A
4	N/A	N/A	N/A
5	D	E	++
6	B	D	+
7	A	B	++
8	A	B	++
9	B	C	++
10	A	B	++
11	A	A	+++
12	D	E	++
13	A/B	A	++*
14	B	C	++
15	A	A	+++
16	C	C/D	++*
17	B	B	+++
18	B/C	C	++*
19	F	F	+++
20	A	A	+++
21	B	B	+++
22	A	A	+++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 56% (including categories 13, 16, and 18)
One level away from perfect agreement is 39%
One item that was two levels away from perfect agreement is the remaining 5%

Eileen's (T8) *STAM* CODES

STAM Sub-Category Number	Principal Researcher	Assistant	Level of Agreement*
1	D	E	++
2	D	D/E	++*
3	C	D	++
4	D	E	++
5	D	E	++
6	C	D	++
7	C	D	++
8	D	E	++
9	C	D	++
10	C	E	+
11	C	C	+++
12	C	E	+
13	C	C	+++
14	D	E	++
15	D	E	++
16	D	C	++
17	D	D	+++
18	D	E	++
19	D	F	+
20	C	C	+++
21	C	B	++
22	D	E	++

* Key to coding symbols
+++ - perfect agreement
++ - one level away from perfect agreement
+ - two levels away from perfect agreement
++* - one researcher shows great spread than the other, but agreement is included within the spread

Summary:
Perfect agreement is 23% (including category 2)
One level away from perfect agreement is 64%
Three items that were two levels away from perfect agreement are the remaining 13%

VITA

Sherri Lynne Brown was born in Greeneville, Tennessee on May 20, 1969. She attended the public schools of Greeneville where she graduated from Greeneville High School in 1987. She moved to Knoxville to attend the University of Tennessee where she graduated with honors in 1991 with a Bachelor of Science in Biology with a concentration in Organismal and Systems Biology. She was immediately employed by Lockheed Martin (formerly Martin Marietta Energy Systems) as a chemical laboratory analyst. After completing four years of laboratory experience, she was granted a fellowship from the Department of Energy to return to the university. In 1996, she graduated from the University of Tennessee with a Master of Science in Curriculum and Instruction and received a secondary teaching license in the subject areas of Biology and Chemistry. She taught Biology, Chemistry, and Physical Science in Knox County and Oak Ridge City school districts. In 1999, she returned to the University of Tennessee to pursue a Doctorate of Education concentrating in Science Education. While completing her doctoral work, she was employed by the University of Tennessee as a graduate teaching and research assistant for three and a half years. Her doctoral degree in Education was conferred December 2002.

She is presently employed by the University of Louisville as an Assistant Professor in the College of Education's Department of Teaching and Learning. She currently teaches elementary science methods courses for the Master of Arts in Teaching program.