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An Exploratory Study of the Impact of an Inquiry-Based Professional Development Course on the Beliefs and Instructional Practices of Urban Inservice Teachers

Leslie Ann Suters
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a dissertation written by Leslie Ann Suters entitled "An Exploratory Study of the Impact of an Inquiry-Based Professional Development Course on the Beliefs and Instructional Practices of Urban Inservice Teachers." 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.

Dr. Claudia T. Melear, Major Professor

We have read this dissertation and recommend its acceptance:

Dr. Russell L. French, Dr. Michael Bentley, Dr. Leslie G. Hickok

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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AN EXPLORATORY STUDY OF THE IMPACT OF AN INQUIRY-BASED PROFESSIONAL DEVELOPMENT COURSE ON THE BELIEFS AND INSTRUCTIONAL PRACTICES OF URBAN INSERVICE TEACHERS

A Dissertation
Presented for the
Doctor of Philosophy
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Leslie Ann Suters
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DEDICATION

This dissertation is dedicated to my mother, Mrs. Sarah Ann Keller, and my husband, Dr. William Henry Suters, III for their constant support and their source as positive role models. Their encouragement and faith in my abilities will continue to inspire me.

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My mother, Sarah Keller, and my husband, Henry Suters, provided considerable support and encouragement throughout my career as a doctoral student. In particular, they read drafts of my dissertation and provided honest and constructive criticism. In addition, I am appreciative of my husband's patience and guidance with word processing programs, without which it would have taken me much longer to complete my dissertation.

ABSTRACT

Five urban teachers completed a total of 50 contact hours, over a seven month period, of professional development, in which they: participated in authentic, inquiry-based experiences facilitated by a scientist; learned new science content related to the nature of science and scientific inquiry; developed inquiry-based lesson plans to implement in their classrooms; and developed science-specific strategies to mentor novice and experienced teachers. The focus of this research was to determine changes in their: beliefs and instructional practices; understanding of scientific literacy; and efficacy toward mentoring other teachers.

A collective case study methodology was used in which participants completed questionnaires and were observed and interviewed, prior to and at the completion of the course. They were also asked to complete reflective journal questions during the course. While the teachers' beliefs did not change as measured by the *Teacher's Pedagogical Philosophy Interview* (TPPI) (teacher-centered beliefs for "Teacher Actions" and "Teacher and Content"; conceptual/student-centered for "Student Actions" and "Philosophy of Teaching"), their teacher-centered behaviors changed to conceptual/student-centered as measured by the *Secondary Science Teachers Analysis Matrix* (STAM). Their responses to the *Constructivist Learning Environment Survey* (CLES) generally correlated with their post-STAM results. Participants gained a better understanding of the creative aspect of the nature of science as measured by the *Modified Nature of Scientific Knowledge Scale* (MNSKS) instrument, while two novice teachers improved their personal science teaching efficacy after participation in the course as measured by the *Science Teaching Efficacy Belief Instrument* (STEBI). Four of the five

teachers felt better prepared to mentor others to use inquiry-based instruction. In contrast to these positive trends, their outcome expectancy beliefs (STEBI subscale) were generally lower than their perceived personal teaching efficacy before and after the course, which could be an indicator of the environment in urban schools where there is often little support or equipment for innovative practices in science. Generally there was a shift from traditional to constructivist instructional practices as measured by the STAM, while results varied for teacher beliefs and efficacy regarding science instruction as measured by the TPPI, CLES, and STEBI and teachers' understanding of the nature of science as measured by the MNSKS.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

Quality science education is necessary to produce citizens who make informed decisions about their world. Scientific achievements have contributed to the quality of life as we know it today and the United States future relies on the accessibility of qualified, knowledgeable citizens in the areas of science and technology. The *National Research Council* and *Project 2061* have suggested goals for a scientifically literate society. Specific goals are to educate students who are able to use knowledge about scientific content, processes, and the nature of science to:

> experience the richness and excitement of knowing and understanding about the natural world; make personal decisions; engage intelligently in public discourse and debate about matters of scientific and technological concern; and increase their economic productivity. (NRC, 1996, p. 13)

Scientific literacy includes the knowledge of scientific concepts, scientific inquiry (processes), and the nature (history, philosophy, sociology, values, and assumptions) of science (AAAS, 1990, NRC, 1996, Schwartz, Lederman, & Crawford, 2000).

The quality of science education has been a major concern in the United States for many years and has been subjected to numerous reform efforts. A commonly referenced motivation for science reform, although not the first, was the space race between the United States and the former Soviet Union that began with the launch of the satellite, Sputnik, in 1957 (Baker & Piburn, 1997). A more recent initiative by the American Association for the Advancement of Science (AAAS) began in 1985 under the name of Project 2061. Science for All Americans (AAAS, 1990) provides the framework for the

dominant reform effort, which describes the information, skills, and attitudes that a high school graduate should know in order to be considered scientifically literate. Subsequent publications such as the Benchmarks for Science Literacy (AAAS, 1993), The Atlas of Science Literacy (AAAS, 2001), and the National Science Education Standards, *NSES* (National Research Council, NRC, 1996) describe how the content should be delivered in developmentally appropriate ways including suggested pedagogical strategies. The goal of current reform efforts in science education is for all students to achieve scientific literacy regardless of race, gender, social status, or disability (AAAS, 1990, NRC, 1996).

America's teachers are responsible for preparing scientifically literate citizens; however, there is a shortage of qualified science teachers. Forty percent of all new teachers leave within the first five years of teaching (Ingersoll, 2003). This problem is more prevalent in urban areas where districts are often forced to hire teachers with little experience. The No Child Left Behind Act, signed into law on January 8, 2002, mandates that by the year 2005 every class should be led by a teacher qualified to teach the subject and grade level. Sixty-five percent of urban science teachers do not have training in the field in which they are teaching and seventy-seven percent of urban schools across the nation have shortages in math and science teachers (McCreight, 2000). Furthermore, 50 percent of new teachers in urban districts transfer to other schools or leave the profession within the first five years (Easley, 2000; McCreight, 2000).

Elementary science education is often impeded because elementary teachers are not sufficiently prepared or even encouraged to teach science (Mulholland & Wallace, 2001). Reading and mathematics have a much greater emphasis at the elementary level and are areas in which teachers are held accountable by standardized testing (Jorgenson

& Vanosdall, 2002). States are not currently required to measure students' progress in science; however, by the year 2007, they will be required to administer annual science assessments in each of three grade spans, 3-5, 6-9, and 10-12. Therefore, science accountability will become an issue for teachers and their school systems.

Statement of the Problem

Scientific Literacy

A recent survey, *The 2001 Survey of Public Attitudes Toward and Understanding of Science and Technology*, which has been given every two years since 1979 by the National Science Foundation (NSF, 2002), revealed that 70 percent of Americans do not understand basic science concepts and two-thirds do not understand the scientific process. The NSF claims that results of the survey have been consistent over the years. Sample questions from this survey include, "In your own words, could you tell me what it means to study something scientifically?" and "Please tell me, in your own words, what is DNA?"

The Third International Math and Science Study (TIMSS) of 1995 compared U.S. curriculum, textbooks, teacher practices and student performance at 4th, 8th, and 12th grades with students internationally in 20-50 (depending on the particular category) different countries. American 4th graders tied for second place in science achievement; however, 8th graders fell to 17th place, while 12th graders (tested in physics) ranked last (Schmidt, McKnight, Cogan, Jakwerth, & Houang, 1999). Several characteristics that can account for a poor performance by American students that Schmidt, et al. (1999) discuss include:

- The amount of time allocated for science instruction did not vary significantly among TIMSS countries; however, American curricula varied at state and local levels and was characterized as a mile wide and an inch deep because more topics were covered superficially at each grade level.
- American textbooks were among the largest and heaviest among all TIMSS countries, reflecting publishers' desires to offer books to multiple states that held varying curriculum standards.
- U.S. textbooks dealt with an average of 55 topics in 4^{th} grade and 68 in 8^{th} grade, compared to international averages of 26 and 30 respectively.
- U.S. eighth grade science classes were less experiment-centered than their international counterparts.

Traditional science instruction within the United States has placed a heavy value on learning concepts with an emphasis on the use of textbooks and lectures. Trends in U.S. public education such as students' avoidance of science and mathematics and low rankings in these subjects on an international basis have established a need for systematic reforms (AAAS, 1990, Schmidt, et al., 1999). Observations of science instruction within the U.S. reveal that students spend the majority of their time learning definitions (National Commission on Mathematics and Science Teaching for the 21^{st} Century, 2000). Although the focus of traditional instruction has been concept attainment, the NSF and the TIMSS surveys reveal that the American method is not as effective as it could be in helping all students retain conceptual or even factual information.

Several researchers feel that the failure of Americans to reach scientific literacy can be attributed in part to a deficiency in learning by scientific inquiry and about the

nature of science, which can lead to the view that science is nothing more than isolated facts that are difficult to apply to the real world (Duggan-Haas, 1998; Melear, Goodlaxson, Warne, and Hickok, 2000; and Schwartz, et al., 2000). Despite the fact that the *Benchmarks for Science Literacy* was published ten years ago and the *NSES*, seven, many teachers (in the U.S.) are clinging to the traditional method of teaching science rather than incorporating many of the guidelines, among them inquiry, suggested by these publications (Jorgenson & Vanosdall, 2002). Furthermore, Lederman, Lederman, Khishfe, Druger, Gnoffo, and Tantoco (2003) state that teachers do not hold accurate perceptions of what constitutes the nature of science or scientific inquiry.

The use of scientific inquiry encourages students to discover scientific principles on their own with the teacher acting as a facilitator. Teachers who use an inquiry approach need to have a knowledge of "science content, student learning, the nature of science, and ways to engage students in investigative practices" (Keys & Bryan, 2001, p. 637). While K-12 teachers who have started teaching within the past 5-6 years may be familiar with the new guidelines and have had opportunities to experience inquiry-based learning, they are inducted into the field of teaching working alongside experienced teachers who have not had these experiences. As new teachers struggle to survive the first years of teaching, they look to experienced teachers as mentors and will likely adopt the method of teaching that they witness their mentor using, which is most likely to be traditional, facts-based instruction.

Teacher Attrition and Urban Issues

Teachers often leave the field due to the lack of preparation, support, and opportunities for advancement (Staten, 1998; Easley, 2000; McCreight, 2000; and

Rhoton & Bowers, 2003). A further analysis of mathematics and science teacher turnover in the United States reveals that 11.4 % retire, 20.2 % leave due to a school staffing action (e.g. layoffs), 37.5 % leave for personal/family reasons, 27.8 % pursue another job, and 39.6 % leave due to dissatisfaction (survey respondents could indicate up to three reasons for departure) (Bureau of National Affairs, 1998). The reasons for departures due to dissatisfaction include poor salary (56.7 %), poor administrative support (45.9%), student discipline problems (29 %), poor student motivation (21.4 %) and lack of faculty influence (12.2 %) (survey respondents could choose up to three reasons) (Bureau of National Affairs, 1998).

Inquiry is advocated by the *NSES* as a method to equalize achievement among students; however, students in urban schools often do not have an equal opportunity to experience learning by inquiry (VonSecker & Lissitz, 1999). Urban schools that also have high populations of minority students are often plagued with a high attrition rate (Kahle, Meece, & Scantlebury, 2000; McCreight, 2000; and Tobin, 2000). Urban schools often exhibit the pedagogy of poverty in which the quality of teaching is compromised by under prepared teachers, insufficient materials, and lack of support for innovative practices (Haberman, 1991; Supovitz & Turner, 2000; VonSecker & Lissitz, 1999).

The National Center for Education Statistics (2002) reported the following enrollment statistics for K-12 public education in the United States for 2000: 61.2% non-Hispanic White, 17.2% Black, 16.3% Hispanic, 4.1% Asian/Pacific Islander, and 1.2% American Indian/Alaskan Native. In contrast the racial distribution of the teacher population for 1999-2000 included: 84.3% non-Hispanic White, 7.8% Black, 5.6% Hispanic, 1.6% Asian/Pacific Islander, and .86% American Indian/Alaskan Native

(NCES, 2003). The total percentage of minority students and teachers was 37% and 13% respectively. There is a major gap in student achievement favoring those students with a high socioeconomic status, those who are members of the dominant culture (non-Hispanic White), and in the case of science achievement, those who are male (Murrell, 2002; Rodriguez, 2001; VonSecker & Lissitz, 1999). One explanation for the lack of student motivation, the student discipline problems, and the achievement gaps that occur in urban schools is that teachers overwhelmingly do not teach urban students with culturally appropriate strategies (Rodriguez, 1998; Jegede & Aikenhead, 1999, Gay 2000).

Statement of the Purpose

The purpose of Project INQUIRE was to provide inquiry-based professional development for K-12 urban teachers in order to increase their ability to conduct inquiry-based instruction as well as mentor other science teachers in its use. The goal, ultimately, was to develop a cadre of teachers that hold the knowledge, skills, and dispositions to implement inquiry-based strategies and improve urban student achievement in science. Inquiry-based strategies, in addition to the more traditional, transmission-method for teaching science, comprise a more culturally relevant teaching repertoire and enhance a teacher's pedagogical content knowledge. Teachers within a large school district in Tennessee participated in the study.

This project was implemented as an outgrowth of The University of Tennessee Title II Teacher Quality Enhancement Grant, Urban IMPACT. Urban IMPACT seeks to improve the preparation of preservice teachers for culturally diverse urban contexts and ensure beginning teachers' success and long-term employment in high needs schools.

The Project INQUIRE course was offered to experienced urban science teachers (K-12) who completed the Urban IMPACT Mentor team training workshops. These cohorts are currently involved as members of school-based mentoring teams that provide support for preservice and new teachers in urban school settings. The mentoring program developed by Urban IMPACT was adopted by the state of Tennessee as the accepted model for mentoring across the state. Project INQUIRE training supplemented Urban IMPACT 's training by providing science-specific mentoring strategies.

The Project INQUIRE course was designed to model inquiry-based instruction for participants. Participants had opportunities to design and conduct experiments with living organisms as part of coursework. Their reflections and scientific inscriptions (notations) were collected as they participated in the course and began to develop inquiry-based lessons for their own classrooms. Many of the activities are also preparatory practices for National Board certification including reflective opportunities, video analysis, and collaboration with colleagues. National Board certification is often a year-long process in which a teacher uses predetermined standards of what constitutes highly accomplished teaching to document his/her practices and knowledge of teaching (NBPTS, 2001).

Providing professional development can empower teachers to use inquiry in their classrooms and help improve the scientific literacy of the teachers and their students. Teachers who have learned effective methods for inquiry implementation can share these methods as part of formal and informal mentoring practices with other teachers. This in turn increases the effectiveness of the programs by promoting change in school culture. "Policy makers who really want to bring about meaningful long-term improvements in

the educational system need to take the risk of investing their limited resources in teachers, the only group with the capacity to reach the learner" (Thier, 2001, p. 13). The quest to reach the goals which have been set by Project 2061 for the scientific literacy of all Americans can be assisted with the use of high quality professional development for science teachers.

Demographic information for the Tennessee county included in this study follow. This county supports 57,000 students in public schools, of which 31% are economically disadvantaged. The racial distribution is 82.3% non-Hispanic White, 14% Black, 1.7% Hispanic, 1.7% Asian, 0.3% Native American, and 0.1% Pacific Islander. This study focuses on teaching strategies that are relevant to African American students which are the predominant minority within this district and are often the majority of students enrolled within the urban schools. Although the 2002-2003 science performance of students for the county as a whole was above the median national percentile for the student grade-levels involved in this study (ranged from 52-58), the science performance of students at the particular urban schools involved in this study was well below the median national percentile (ranged from 17-35).

Research Design

Overview of Study

The key components of the Project INQUIRE course were delivered in five, three-hour workshops, a three-week summer course, and one professional development leave day from April through October 2003, for a total of 50 contact hours. The selected teachers were interviewed and observed in their classrooms prior to and at the completion of their coursework. Data analysis of interviews and classroom observations began as

soon as they were collected to prevent the distortion of information over time. Participants were asked to conduct outreach activities by presenting the development of lesson plans and student artifacts at the Tennessee Science Teachers' Association (November 2003).

Research Questions

Several questions provide the framework for the design of this study.

1. Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?
2. Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?
3. Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?
4. Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?

Study Population

Participant selection was based upon employment in a K-12, urban school and the following conditions:

- Completion of Urban IMPACT mentor training - The teachers who received the Project INQUIRE training are expected to mentor new and experienced teachers in the process of using inquiry. In an effort to select teachers who already had a commitment to urban schools and to mentoring, the participants were expected to

be a part of the school's mentor core team and to have received the mentor training offered by Urban IMPACT or be recommended to join the mentoring team and willing to receive the training during the 2003-2004 school year.

- Elementary school teachers responsible for teaching science as part of their daily responsibilities or secondary school teachers who teach middle or high school science

After a search of teachers who met the above qualifications, five teachers were selected for and participated in the Project INQUIRE course. Their teaching responsibilities ranged from Kindergarten through sixth grade (four elementary teachers and one middle school teacher). Attempts were unsuccessful to recruit additional middle school and high school teachers. Chapter III and IV present additional demographic information regarding individual participants.

Methods and Procedures

A collective case study methodology was used to organize the approach to this research. The research questions have been answered using a mixture of qualitative (interviews, observations, reflections and questionnaires) and quantitative (questionnaires) measures. Chapter III provides a detailed description of the methodology and each instrument used in this study.

Participants completed questionnaires and were observed and interviewed, prior to and at the completion of the Project INQUIRE course. Selected questions from the Teacher's Pedagogical Philosophy Interview (TPPI) were used to collect information pertaining to changes in participant's instructional practices, their beliefs and attitudes about science instruction, and their understanding of scientific literacy (Salish I Research

Project Supplement, 1997). Additional interview questions were added to the TPPI questions in order to determine changes in participant's understanding of scientific inquiry.

The Secondary Science Teacher Analysis Matrix (STAM) was used to document each teacher's practices during classroom observations (Gallagher & Parker, 1995). This instrument was used to classify teaching strategies on a continuum between didactic and constructivist. Each teacher was observed and videotaped during approximately 3-4 hours of science instruction before and after participation in the Project INQUIRE course. The Science Teaching Efficacy Belief Instrument (STEBI) was used to determine changes in teachers' beliefs and attitudes toward science instruction (Enochs & Riggs, 1990).

The Constructivist Learning Environment Survey (CLES) was used to gather teachers' perceptions of how often they implemented constructivist instructional practices (Salish Research Project Supplement, 1997). The Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP) provided supplemental information about each teacher's instructional practices that otherwise would not be gathered by the interviews and observations (McGlamery, 1993). The Modified Nature of Scientific Knowledge Scale (MNSKS) was used to determine changes in each teacher's understanding of the nature of science (Meichtry, 1992). The teachers completed the Mentoring Efficacy Questionnaire developed by Urban Impact to help determine their perceived strengths and weaknesses acting as a mentor to colleagues.

Participants responded to reflective journal questions while they were taking the Project INQUIRE course. The teachers were asked to reflect upon how they would apply

what they were learning in their own classrooms with the following questions: What is scientific thinking?; What is the nature of scientific thinking, and specifically, yours?; How is your scientific thinking developing?; and What is the nature of science?. They also reflected upon how they would use the information they learned in the Project INQUIRE course to mentor their colleagues.

Assumptions of the Study

The following assumptions underlie the study:

1. Instruction within this county's schools is highly textbook driven which leads to the traditional transmission-approach of teaching (personal conversation with county science supervisor).
2. The teachers selected for this study had not experienced inquiry-based learning themselves and therefore could benefit from inquiry-based professional development.
3. The teachers would be able to develop and implement inquiry-based instruction as a result of taking the course.
4. Inquiry-based instruction is constructivist by nature and a culturally relevant teaching strategy, appropriate to use within these teacher's urban classrooms.
5. Participants provided accurate, honest responses to interviews and questionnaires.
6. The TPPI, STAM, CLES, MNSKS, and STEBI instruments were coded accurately according to the procedures provided for each document.

Limitations of the Study

The following limitations underlie the study:

1. Participants were limited to urban, K-12 teachers that teach science. However, attempts to recruit teachers at the secondary level (grades 7-12) were unsuccessful. Only 5 teachers participated in the study.
2. Mentoring was not observed; only perceived efficacy and self-report of mentoring was collected.
3. The pre-observations were collected toward the end of one school year with one set of students while the post-observations were collected at the beginning of the next school year with a different set of students.

Importance of the Study

Several areas in which the current research base in inquiry-based professional development programs is lacking include 1) research in culturally diverse settings, 2) inquiry-based instruction that is designed by teachers (not pre-packaged by researchers), 3) teachers' knowledge and views about the goals and purposes of implementing inquiry, 4) teachers' motivation for inquiry teaching, 5) research regarding inquiry in the regular classroom (as opposed to a specialized ecology course for example), and 6) research at the secondary level of education (Keys & Bryan, 2001). The Project INQUIRE course addresses each of these issues with one exception. The participants were K-6 teachers within urban schools. Attempts were made to recruit teachers from the high school level; however, none of these teachers were able to commit to the course.

The teachers were part of mentor core teams within their respective schools (two were trained by Urban IMPACT after Project INQUIRE participation) and were responsible for mentoring new and, at times, experienced teachers. The Project INQUIRE professional development course was designed to provide the participants opportunities to 1.) collaborate with each other as well as with a scientist, 2.) participate in authentic, inquiry-based learning experiences, 3.) learn new science content and concepts related to the nature of science and scientific inquiry, and 4.) develop science-specific strategies to mentor novice and experienced teachers. As a result of this project, they became a resource on inquiry-based instruction, a form of culturally relevant teaching, to the teachers within their schools. Systemic change requires time and the teachers chosen for this project have been empowered to continue learning about inquiry and their own practices as they continue to mentor other teachers.

Definition of Key Terms

Activity (Structured inquiry) - a teacher-designed question and experiment; also known as the "cookbook" method

Constructivism - "the contemporary view of learning (in which) people construct new knowledge and understandings based on what they already know and believe" (National Research Council, 2000b, p. 10)

Coupled Inquiry - Any combination of the following: activity (structured inquiry), guided inquiry, or open/full inquiry

Culturally Relevant Teaching - "(uses) cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1994, p. 18)

Economically Disadvantaged - Students who receive lunch assistance; also an indicator of low socioeconomic status

Guided Inquiry - Inquiry in which the teacher develops a question and allows the student to co-construct the experimental design

Inservice Teacher - a practicing teacher

Magnet School - "A public elementary school, public secondary school … that offers a special curriculum capable of attracting substantial numbers of students of different racial backgrounds" (U.S. Department of Education, www.ed.gov/legislation/ESEA02/pg65.html)

Mentor Teacher - an inservice teacher responsible for mentoring a novice or preservice teacher and in some cases experienced teachers

Novice Teacher - a new teacher within the first three to five years of teaching

Open/Full Inquiry - Inquiry in which the student develops a question, and designs and conducts his/her own experiment (individual or as part of a group)

Pedagogical Content Knowledge - "the ways of representing and formulating the subject that makes it comprehensible for others" (Shulman, 1986, p. 9)

Philosophy of Teaching - "the teacher's beliefs about the nature of teaching and learning" - Definition also included "view of self as teacher" for this study - "the teacher's self-concept as an instructor, such as the metaphors they used to describe themselves in their roles in the classroom" (Simmons, et al., 1999, p. 935)

Preservice Teacher - a student within a teacher preparation program

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

Special Needs Student - students with health impairments (i.e. deaf) or who are academically or emotionally disabled

Student Actions - "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 Actions - "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)

Teacher and Content - "how content and processes of science/mathematics were presented to students along four dimensions: structure of content; examples and connections; limits, exceptions, and multiple interpretations; and processes and history of science/mathematics" (Simmons, et al., 1999, p. 935)

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

Organization of the Study

This dissertation includes five chapters.

Chapter One provides the introduction to the study and a statement of the problem including scientific literacy, teacher attrition, and urban issues. It also includes a statement of the purpose, the research design (including an overview of the study, research questions, the study population, and methods and procedures), assumptions and

limitations of the study, and the importance of the study. Chapter one concludes with definitions of key terms.

Chapter Two contains a review of the literature and is reported in three sections. The sections are: issues pertaining to scientific literacy (including inquiry and nature of science issues), culturally relevant teaching (CRT) strategies (including the need for CRT, theoretical approaches, and issues related to African American culture and learning styles), and inquiry-based professional development.

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

Chapter Four reports the study's findings and is reported in three sections. The first section includes within case analyses of basic demographic information, analysis of the four research questions, and a participant summary for each of the five participants. Section two presents a cross-case analysis of the five teacher participants arranged by the four research questions and a presentation of themes developed from the interview responses and journal reflections. Section three presents key findings of the within-case and cross-case analyses.

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

CHAPTER II: REVIEW OF LITERATURE

Scientific Literacy

Inquiry

Historical Development of Inquiry

Before World War II there was little public interest and financial support for science education; however, after the war, science was valued for it's potential to improve anything from the health to the security of all Americans (Baker & Piburn, 1997). Efforts to improve science education helped establish the creation of the National Science Foundation (NSF). During the late 1950's and early 60's, science education focused on the "student as scientist" by fostering the preparation of the "elite" for science. During this period, the NSF funded what has become known as the "alphabet soup curricula" in response to the nation's space race with Russia (Baker & Piburn, 1997; Martin, 1997). The NSF-funded programs focused on a range of hands-on approaches to science education: The Chemical Education Materials Study (CHEM Study) and The Elementary Science Study (ESS) focused on the *discovery approach* in which students "discover" concepts independently of the teacher; Science A Process Approach (SAPA) focused on the *process-oriented approach* in which the processes of science are emphasized rather than the content; The Biological Sciences Curriculum Study (BSCS) focused on the *inquiry-approach* in which students develop and pursue their own questions with the teacher acting as a guide; and The Science Curriculum Improvement Study (SCIS) focused on the *learning cycle approach* which is a combination of the other three approaches (Ruby, 2001).

In the 1970's, the "race" to improve science was abandoned because of the concern that current science practices were failing. Achievement of American students was unfavorable internationally particularly in comparison with Japan, and there was a decrease in the number of prospective science teachers (Baker & Piburn, 1997). There was a shift from the nationally funded curricula of the NSF toward a Science and Technology Approach in an effort to make "science relevant to students' lives and focus on socially relevant issues such as the environment" (Ruby, 2001).

Project 2061 (American Association for the Advancement of Science-AAAS) which promotes teaching through the *inquiry approach* was initiated in 1985 in response to the growing concerns regarding science education. The efforts of the AAAS reflected society's goals to improve scientific literacy for all Americans, not just the elite. The NSF shifted its focus from national to more localized projects through Statewide, Urban, Rural, and Local Systemic Initiatives which focused on integrating "content, teaching method, and practice in schools" (Baker & Piburn, 1997, p. 7). These initiatives primarily supported professional development for teachers and the purchase of materials for participants to enact the standards developed by Project 2061 (AAAS, 1993; *Benchmarks*). The curricula developed through these initiatives included a combination of hands-on approaches ("cookbook" method, exploratory, and process) in addition to the inquiry approach (Ruby, 2001). There is a difficulty in defining inquiry to an extent that it can "be packaged in a curriculum and used by a large number of teachers" (Ruby, 2001, p. 23).

Constructivist Influences on Inquiry

Most teachers are products of our traditional educational system in which behaviorist practices are fostered. Behaviorist theory considers "learning to be a change in behavior", and leads to the didactic (teacher-centered) strategy by which students are viewed as "blank slates in which information is inputted and processed" (Llewellyn, 2002, p. 40-41). As opposed to behaviorist theory, cognitive research regarding how people learn focuses on providing relevant experiences and opportunities to allow students to construct knowledge (Piaget, 1970; Vygotsky, 1978; National Research Council, 2000b). "Experience, not repetition or memorization, is the key to retention and, therefore, to genuine learning" (Thier, 2001, p. 26). The values of constructivism have informed and guided teacher researchers for the past two decades but have had little effect on actual classroom practices (Rodriguez 2001). This is largely due to the fact that many practicing teachers have not had experiences with learning in constructivist ways and are not likely to implement teaching strategies that they have not experienced themselves (Radford & Ramsey, 1996; Staten, 1998; Villegas & Lucas, 2002).

Current views of constructivism have developed from theorists such as John Dewey, Jean Piaget, and L. S. Vygotsky. All three theorists viewed learning as an active process of constructing knowledge with connections to prior learning; however, they attributed learning to different contexts. Dewey felt that learning should be meaningful to each student and that teachers should act as facilitators, "who are able to step back from children's activity and let it run its own course" (Glassman, 2001, p. 3). Piaget (1970) was the founder of the individualistic approach that advocated the individual

construction of knowledge in developmentally appropriate stages (i.e., the use of hands-on experiences prior to vocabulary introduction). Vygotsky felt that learning occurred in a socially constructivist manner. According to Vygotsky (1978), people learn from each other in social situations. "Knowledge is personally constructed but modified by the social context in which learning takes place" (Plourde & Alawiye, 2003, p. 2). This social interaction is the key to enabling students to operate inside the two borders of the zone of proximal development (ZPD). The ZPD is defined as:

> The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978, p. 86)

Vygotsky asserted that teachers and/or students could lead learners to function in their ZPD by acting as "knowledgeable others" or mentors who help to guide activities (Glassman, 2001). As knowledge of the processes of learning and teaching has grown, Vygotsky's incorporation of the social and cultural context of constructivism has more credence than the cognitive/individualistic views of Piaget and Dewey alone (Keys & Bryan, 2001; Plourde & Alawiye, 2003).

The goals for scientific literacy advocate providing experiences and opportunities for action and reflection. Scientific inquiry, in particular open inquiry, allows students to be active by asking and pursuing their own questions in order to construct meaningful, reflective understanding. Teaching constructively involves assessing students' prior knowledge and helping them connect new information with past experiences (Duit &

Treagust, 1995). Pre-assessment also allows teachers to uncover misconceptions and suggests opportunities to promote conceptual changes in student understanding (Duit & Treagust, 1995; Llewellyn, 2002). This construction of knowledge should take place in a collaborative situation between students and their teacher that allows students to develop inquiry skills though social interaction and reflection (Duit & Treagust, 1998; Lave & Wenger, 1991; Vygotsky, 1978).

> Constructivist philosophy does not dictate how one should teach; however, it does make it incumbent upon the teacher to deal with each learner as an individual, to value diversity of perspective, and to recognize that the learner's behavior is a direct reflection of his/her life experiences. (Plourde & Alawiye, 2003, p.2)

Therefore, although learning occurs socially, teachers need to be aware of the individual characteristics and experiences or each learner.

Description of Inquiry

Inquiry instruction can be defined as giving students opportunities to design and conduct their own investigations related to concepts and issues that are relevant to the curriculum. Hands-on, problem-based, activity-based, project-based, standards-based, and inquiry-based are among the many terms that have been used to describe this type of science instruction. However, even though an activity might be described using one of these terms (even inquiry-based) it may not actually fit the definition of inquiry instruction given above.

Many teachers assume that hands-on activities alone constitute inquiry-based (I-B) instruction. However, "hands-on" experiences that are also "minds-on" are a better representation (NRC, 1996; Moscovici & Holmlund Nelson, 1998). Knowledge of

scientific processes, including inquiry, is one of the major components of scientific literacy. The National Research Council (2000a) advocates five essential features exhibited as part of inquiry used in classrooms:

> Learners are engaged by scientifically oriented questions; learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions; learners formulate explanations from evidence to address scientifically oriented questions; learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding; and Learners communicate and justify their proposed explanations. (p. 23)

Martin-Hansen (2002) describes four types of inquiry that are often used for instruction including open or full, guided, coupled, and structured inquiry that range from student-centered to teacher-centered respectively. *Open or full inquiry* is defined as students asking their own questions, designing investigations, and communicating results. *Guided inquiry* is defined as the teacher choosing a question to pursue and allowing the students to help decide how to answer the question through investigation. *Coupled inquiry* begins as a teacher-guided inquiry or as structured inquiry and is followed up with an inquiry with less teacher control. For example, the students are allowed to pursue their own questions that have developed as a consequence of guided instruction. *Structured inquiry* is more teacher-directed and sometimes not considered to be a true inquiry experience. In structured inquiry, the teacher develops the question and then guides the students through a series of steps toward a known answer. Llewellyn (2002) would label full/open inquiry as student-initiated, guided inquiry as teacher-initiated, and

structured inquiry as an activity (not an actual form of inquiry). "An activity can be thought of as a type of cookbook activity, and although it is hands-on, it is not inquiry-based" (Llewellyn, 2002, p. 67).

Figure 1 is a graphical representation of Martin-Hansen's (2002) and Llewellyn's (2002) ideas regarding inquiry. As teachers analyze activities that are labeled as hands-on, problem-based, activity-based, project-based, standards-based, or inquiry-based, they should find that the activities fall into one of the four categories described. An important aspect of all I-B activities is the central position of content that should be learned as part of the process. Activities and inquiries are appropriate under different circumstances and the style should be varied to meet the needs of all learners. A common method used to develop I-B lessons is called the Learning Cycle or the 5-E's (Bybee, 1997; Llewellyn, 2002). This model includes five phases: *engaging* the student; allowing the student to *explore* the concept or materials; an *explanation* of the concept (by teacher or student); an *elaboration* or *extension* through additional experiences; and an *evaluation* of learning by the teacher alone or in combination with students.

The *Benchmarks* (AAAS, 1993) and the *NSES* (NRC, 1996) provide developmentally appropriate expectations, goals, and examples for how content (e.g., earth, physical, and life science) should be delivered using inquiry and other pedagogical strategies. Furthermore, inquiry is included in these standards documents as an integral part of the science content. If students are going to learn what science is like, they need to have opportunities to experience this process. Incorporating inquiry as a content standard within a curriculum encourages teachers to engage students in linking authentic scientific processes with scientific knowledge.

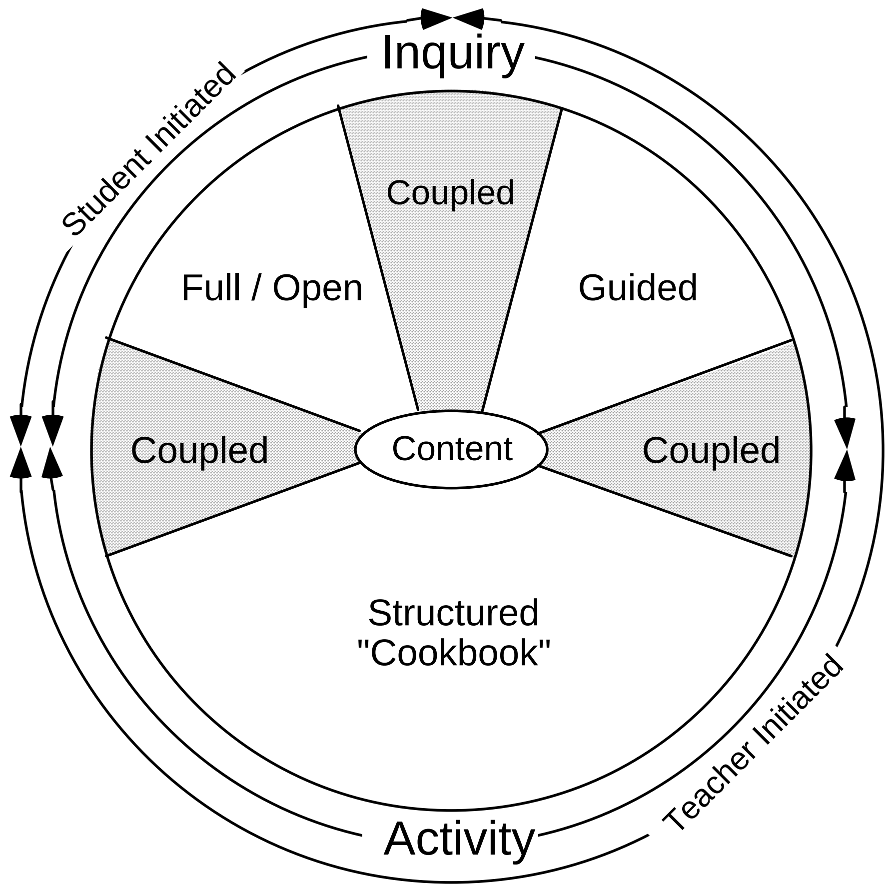


Figure 1. Inquiry Versus Activity.

> Engaging students in inquiry helps students develop: understanding of scientific concepts; an appreciation of "how we know" what we know in science; understanding of the nature of science; skills necessary to become independent inquirers about the natural world; and the dispositions to use the skills, abilities, and attitudes associated with science. (NRC, 1996, p, 105)

Table 1 includes developmentally appropriate abilities necessary to do scientific inquiry and the understandings about scientific inquiry outlined by the *NSES*. The *Benchmarks* provide a similar description of expectations; however, it uses four divisions of grade levels (K-2, 3-5, 6-8, and 9-12). Both documents recommend introducing students to investigations that are increasingly similar to authentic science as they progress through school and have had previous opportunities to participate in investigations directed by the teacher. Specific suggestions include focusing on the quality rather than the quantity of investigations and allowing students to develop their own procedures rather than providing step-by-step instructions.

> Before graduating from high school, students working individually or in teams should design and carry out at least one major investigation. They should frame the question, design the approach, estimate the costs involved, calibrate the instruments, conduct trial runs, write a report, and finally, respond to criticism. (AAAS, 1993, p. 9)

Constraints to I-B instruction include short class periods, large class sizes, supervision practices that reward non-constructivist practices, a school culture apathetic to science, and classroom management practices that reflect behaviorist ideology (Mulholland & Wallace, 2001; Staten, 1998). Keys and Bryan (2001) describe how

Table 1. Science As Inquiry, Student Abilities and Understandings, NSES (NRC, 1996).

Grades K-4 (p. 122-124)	Grades 5-8 (p. 145-148)	Grades 9-12 (p. 175-176)
	ABILITIES	
	Questions	
Ask a question about objects, organisms, and events in the environment.	Identify questions that can be answered through scientific investigations.	Identify questions and concepts that guide scientific investigations.
	Design	
Plan and conduct a simple investigation.	Design and conduct a scientific investigation.	Design and conduct scientific investigations.
	Tool Usage	
Employ simple equipment and tools to gather data and extend the senses.	Use appropriate tools and techniques to gather, analyze, and interpret data. Use mathematics in all aspects of scientific inquiry.	Use technology and mathematics to improve investigations and communications.
	Data collection and Analysis	
Use data to construct a reasonable explanation.	Develop descriptions, explanations, predictions, and models of evidence. Think critically to make the relationships between evidence and explanations. Recognize and analyze alternative explanations and predictions.	Formulate and revise explanations and models using logic and evidence. Recognize and analyze alternative explanations and models.
	Communication	
Communicate investigations and explanations.	Communicate scientific procedures and explanations.	Communicate and defend a scientific argument.
	UNDERSTANDING	
Understand that scientists: • ask questions and compare answers with what is known • use description, classification, and experimentation • explain using observations based on investigations • make investigations public • review other scientists' work	Understand: • different questions suggest different kinds of investigations • current knowledge guides investigations • importance of math and technology • science advances through skepticism and when explanations are displaced by better evidence • investigations can result in new ideas, studies, methods, or technologies which can lead to new investigations	Understand: • historical and current knowledge influence design and evaluation • scientists investigate for a variety of reasons • technology enhances the gathering and manipulation of data • math is essential • explanations must adhere to criteria - e.g., consistent, open to questions and modification • results of scientific inquiry emerge from different types of investigations and communication among scientists

teachers' beliefs that traditional science instruction is a more efficient method conflicts with implementing I-B instruction:

> Teachers hold personal beliefs that inquiry promotes the scientific thinking and learning autonomy they want for their students; yet, enacting inquiry is mediated by cultural beliefs, such as transmission and efficiency. These dual belief sets cause tension for teachers who are attempting to use inquiry-based instruction. (p. 636)

Assessment of Inquiry

As teachers initiate Inquiry-Based (I-B) methods of instruction into the classroom they also include alternate methods of assessment. There is a need to supplement the standard, summative form of assessment, which normally consists of paper and pencil tests used to calculate grades (NRC, 1996, Wright, 2001). Within I-B classrooms, data from assessment is used formatively to guide learning and plan teaching. Authentic assessment which can be summative as well as formative is often used and includes exercises that "require students to apply scientific knowledge and reasoning to situations that approximate how scientists do their work" (NRC, 1996, p. 78). Methods used to collect authentic data can include the use of demonstrations, interviews, inscriptions, journals, portfolios, performances, observations (checklists), scoring rubrics, self-evaluations, and concept maps (NRC, 1996; Layman, 1996; Llewellyn, 2002; Wright, 2001, Roth & McGinn, 1998).

Assessment of competence of student performance is important in I-B classrooms and involves asking students to: "generate rather than choose a response; actively

accomplish complex and significant tasks; and solve realistic or authentic problems" (Layman, 1996, p. 44). Assessment is also embedded as part of the inquiry task.

> These embedded assessments weave the tasks on which the students are assessed into the learning activities, projects, and investigations that students conduct as routine elements of their learning. The activities designated as assessment tools are carefully crafted to resemble as closely as possible any other day-to-day activity. (Layman, 1996, p. 115)

The inquiry activities themselves, such as completion of an open inquiry, become the assessment task. Formative assessments can include the questions that teachers ask or their observations of students during lessons by using checklists and/or rubrics (NRC, 2000a).

Another type of assessment which is equally important is students' self-assessment. "Students should be trained in self-assessment, so that they can understand the main purposes of their learning and thus what they need to achieve" (NRC, 2000, p. 80). The NRC (2000a) suggests ways to incorporate student self-assessment including allowing students to assist in creating a rubric. It is important to supply students with rubrics or other guides prior to performing inquiry activities so they will know the criteria that will be used to determine grades.

Teaching Accountability and Inquiry

Many teachers know of the benefits of incorporating scientific inquiry into their classrooms; however, they feel pressured to prepare students for standardized tests and do not feel they have time to spare to allow students to pursue inquiry. Furthermore,

elementary teachers are often not encouraged to teach science due to the emphasis on achievement in reading and math (Jorgenson & Vanosdall, 2002). With the current emphasis on accountability, it is important to move beyond anecdotal evidence and examine the effects of I-B instruction on students' science achievement. If I-B instruction is to be used in the public science curriculum (as wide as it is), it must be shown by standardized tests to improve science achievement. There is a need for empirical research in this area; however, there has been some significant progress. Examples of exemplary I-B science programs at the elementary and middle school levels (the levels represented in this research) are presented in this section.

Elementary-school level.

An innovative, I-B program in Wisconsin, called the Einstein Project, has been shown to improve elementary students' achievement in science (The Einstein Project Cornerstone Study, 2003). The Einstein Project was incorporated in 1991 and has established a resource center that leases curriculum units (including supplies) to Wisconsin schools. The curriculum units were developed by the National Resources Center, the Smithsonian Institution and the National Academy of Sciences (Science and Technology for Children - STC). As of 2002, the Einstein Project had trained 2200 teachers in 220 schools to use the curriculum materials, impacting 200,000 students. An unbiased survey center was commissioned to determine the effectiveness of the Einstein program. A group of 10, 3rd grade classes, 5 Einstein and 5 non-Einstein, were compared using a series of assessments in the content areas of plants, rocks, and sounds (selected curriculum units used in the Einstein classrooms). Two of the assessments included a pre/post general science knowledge test (adapted from among others Terra Nova and

California Achievement tests) and a combined written and performance test covering plants, rocks, and sounds (distributed as a post-test). Students within Einstein classes outperformed non-Einstein students on these assessments and additionally were shown to use correct science terminology 81% of the time compared to 20% for the non-Einstein (as part of the performance assessment).

Jorgenson and Vanosdall (2002) describe an urban school district in El Centro California that placed a district-wide emphasis on I-B science instruction at the elementary level. This district found that over time, math and reading achievement scores improved for 4^{th} and 6^{th} graders as a result of using I-B instruction. This is an important finding due to the fact that there is a greater emphasis from bureaucratic pressures (such as the No Child Left Behind Act) placed on teaching math and reading skills at the elementary level, often to the exclusion of science. The El Centro school district compared 4^{th} and 6^{th} graders that received I-B instruction with those who had not been exposed to I-B instruction from 1995-1999. They found that students within I-B classrooms scored 35 % better in math and 28 % better in reading in addition to improved science achievement scores. Furthermore, 6^{th} grade students receiving the treatment averaged 89 % on the district writing proficiency exam compared to a 23 % average for the control group.

Middle-school to secondary level.

I-B instruction has been shown to improve the performance of urban, African-American, middle school, science students on standardized tests (Kahle, Meece, Scantlebury, 2000). Kahle, Meece, & Scantlebury (2000) studied the results of Ohio's Statewide Systemic Initiative (1994-1999) sponsored by the National Science Foundation

to improve mathematics and science instruction. As part of this initiative, teachers received professional development (on a volunteer basis) to encourage the use of standards-based instruction and assessment (defined as varied types of instruction including: cooperative groups, open-ended questioning, extended inquiry, problem solving, and embedded assessment such as portfolios and performance tasks). The professional development also focused on improving teachers' content knowledge in physics by offering courses that were taught by inquiry.

A random sample of 8 trained teachers (7^{th} and 8^{th} grade levels) from different schools that enrolled at least 30% minority students were selected as representatives of treatment groups. At least one, non-trained, teacher from each school was selected for control groups (n=10). All African American students within each of the teacher's classes formed the student sample (n=196 for focus group and 178 for control group). Achievement was measured using the *Discovery* Inquiry Test for science developed for Ohio's Initiative using the National Assessment for Educational Progress (1990 and 1992) release test items (achievement scores were converted to standardized scores). Results indicated that students in the treatment groups scored higher on the Discovery Inquiry Test than the students in the control groups. Students in treatment groups also reported a higher frequency of standards-based teaching practices in use by their teachers than those in control groups.

White & Fredrickson (1998) compared the performance of seventh through ninth grade urban students who participated in inquiry-based physics instruction with eleventh and twelfth grade suburban physics students taught by conventional methods. The students receiving the inquiry-based approach had a better understanding of fundamental

physics principles (motion). The Thinker Tools Inquiry Curriculum was used for the treatment classes and this curriculum is based on student-generated questions, experimentation, and metacognitive reflection. The treatment group excelled on qualitative problems involving real-world situations. Findings revealed the potential of I-B instruction, as used in the Thinker Tools curriculum, to increase the understanding of science content and inquiry, especially with economically disadvantaged, urban students (Keys & Bryan, 2001).

Nature of Science

Description of the Nature of Science

The Nature of Science (NOS) is an important aspect of scientific literacy that incorporates the values and assumptions that are inherent to the field of science. Students and teachers often have misconceptions regarding the NOS which can be attributed to "science curricular materials and instructional practices which do not adequately reflect the nature of scientific knowledge" (Meichtry, 1992). Lederman, Khalick, Bell, & Schwartz (2002) describe the interdependence and distinction of scientific processes and the NOS:

> We consider scientific processes to be activities related to the collection and interpretation of data, and the derivation of conclusions. NOS, by comparison, is concerned with the values and epistemological assumptions underlying these activities. (p. 499)

As described in Table 2, the NOS is tentative, empirical, a product of human activity, socially and culturally embedded, and has a unified set of properties across scientific disciplines (AAAS, 1990; NRC, 1996; Lederman, et al., 2002; Meichtry, 1992). "The statements of

Table 2. What the Standards and Literature Say About the Nature of Science.

SFAA (ch. 1, pp 1-12) Nature of Science (AAAS, 1990)	NSES (pp. 201-202, 204) **History and Nature of Science (grades 9-12) (NRC, 1996)	Lederman et al., 2002 (p. 449)	Meichtry, 2002 (p. 391)
The Scientific World View • world is understandable • scientific ideas are subject to change • scientific knowledge is durable • science cannot provide complete answers to all questions	Nature of Scientific Knowledge • subject to change as new evidence becomes available	Science is: tentative	Science as developmental/tentative
Scientific Inquiry • demands evidence • blend of logic & imagination • explains & predicts • identifies & avoids bias • not authoritarian	Nature of Scientific Knowledge • distinguished through use of empirical standards, logical arguments, and skepticism • explanations must meet certain criteria: consistent with experimental and observational evidence, logical, respect the rules of evidence, open to criticism, report methods and procedures, and make knowledge public	Science is: • empirical • partly the product of human inference, imagination, and creativity • theory-laden It is important to distinguish between: • observations and inferences • theories and laws There is a lack of a universal recipe-like method for doing science	Science as a creative endeavor: partially a product of human creativity Science as testable: capable of empirical test
The Scientific Enterprise • complex social activity • organized into content disciplines; conducted in various institutions • conducted ethically • scientists participate in pubic affairs as specialists & citizens	Science as a Human Endeavor • individuals & teams have and will contribute • scientists have ethical traditions (peer review, truthful reporting, publicizing work) • part of society; influenced by cultural, and personal beliefs	Science is: • socially and culturally embedded	Science as a unified set of properties: the specialized sciences contribute to an interrelated network of laws, theories, and concepts

** The NSES suggest teaching about the history of science as a method to help students understand the nature of science and how it has developed over time.

science should never be accepted as 'final truth.' Instead over time they generally form a sequence of increasingly more accurate statements" (National Academy of Sciences, p. 30). Although the statements of science should not be accepted as final truth, many theories are no longer questioned by scientists.

Ideas About Teaching the Nature of Science

Empirical research has shown that the tenets of the NOS should be taught explicitly (Khishfe & Abd-El-Khalick, 2002; Schwartz & Crawford, 2003). Immersing students in inquiry experiences and hoping that they will gain implicit knowledge of the NOS is not enough. Students must be exposed to discrepant events and have opportunities to reflect upon them (NSTA, 1998; Bell, Blair, Crawford, & Lederman, 2003). Schwartz & Crawford (2003) point out that it's important to understand that one does not "do NOS." One can do science, which can lead to an understanding of the NOS through reflection and dialogue.

Teachers of science must have opportunities to conduct inquiry activities and reflect about the NOS if they are expected to provide reciprocal activities for their students (NBPTS, 2001). They should also have an understanding of the cognitive capabilities of students at their grade level and be aware of suggested strategies to address the needs of all learners. Teachers that hold an accurate view of the NOS are more likely to implement a problem-based approach to science instruction (Keys & Bryan, 2001). Vygotsky's theory of the zone of proximal development (1978) describes how learners can achieve more when working alongside more knowledgeable others and ties in closely

with the values and assumptions relevant to the NOS, in particular the idea of science as a socially and culturally embedded activity.

The National Science Teachers' Association (NSTA) has recommendations for preparing preservice teachers to teach about the NOS in their *Standards for Science Teacher Preparation* (1998). They also provide indicators for what should be observed at the preservice, induction, and professional levels. For example an indicator of how a professional level inservice teacher implements NOS concepts is he/she, "involves students in inquiries pertaining to the nature of science including historical and philosophical changes that have shaped subsequent knowledge and the social interpretation of knowledge and events" (NSTA, 1998, p. 9). The National Board of Professional Teaching Standards (Early Adolescence Science, 2001) claims that:

> The transformation of a classroom of students from a group of passive individuals into a community of actively engaged learners marks accomplished science teaching…the point of departure for establishing such a productive learning climate is a deeply structured knowledge of the nature of science and the inquiry process. (p. 18)

Section Summary

Instruction that resembles the authentic practices and nature of science is an appropriate starting point for promoting scientific literacy. Efforts to improve science education helped establish the creation of the National Science Foundation (NSF). During the late 1950's and early 60's, science education focused on the preparation of the

"elite" for science and the NSF-funded programs focused on a range of hands-on approaches to science education.

Project 2061 (AAAS), initiated in 1985, promotes teaching through the *inquiry approach*. Scientific inquiry, in particular open inquiry, allows students to ask and pursue their own questions in order to construct meaningful understanding. Assessment practices used for inquiry are often authentic activities that scientists use in their research such as laboratory inscriptions, portfolios, and self-assessment. The use of inquiry has been shown to make a positive impact on the achievement of students.

The Nature of Science (NOS) includes the view that science is creative, testable, developmental, and unified. Empirical research has suggested that the aspects of the NOS need to be discussed explicitly in the context of science activity in order for students to develop an understanding of the NOS. Teachers of science must have opportunities to conduct inquiry activities and reflect about the NOS if they are expected to provide reciprocal activities for their students.

Culturally Relevant Teaching Strategies

The Need for Culturally Relevant Teaching

Science instruction has traditionally been structured to reach and teach the elite of our society. Science reform as advocated by the AAAS (1989) and the National Research Council (1996) calls for science for all Americans. Schools should give all children equal opportunities for success; however, they are structured to the advantage of middle and upper class students. Widely accepted practices of grouping and tracking students in schools exacerbates the problem by trying to place students in homogeneous

groups that reproduce the power relationships found in our society (Ballantine, 2001 and Rodriguez 1998).

America's student population is becoming increasingly diverse. By the year 2020 between 40-50 % will be students of color (Irvine & Armento, 2001; Murfin, 1994). There is a major gap in student achievement favoring those students with a high socioeconomic status and those who are part of the culture of power (non-Hispanic White) (Murrell, 2002 and Rodriguez, 2001). The school can play a central role in addressing damaging social issues such as the incarceration rate of black males and the teenage pregnancy rates of black females: "Everyone does not have a functional family, nor does everyone attend church; but everyone is required to attend school" (Hale, 2001, p. 112). The American Association of Colleges of Teacher Education (1995) reported that 80% of our preservice teachers are white females who are not prepared for and are unfamiliar with students of color. These and other issues including the high drop-out rates of underserved ethnic groups from public schools establish the need for changes in our current construct and delivery of curriculum in public schools.

Teachers who use culturally relevant teaching (CRT) strategies such as I-B instruction make informed decisions about the implementation of curriculum based upon the culture, learning styles, and individual needs of their students. A CRT approach "empowers students intellectually, socially, emotionally, and politically by using cultural referents to impart knowledge, skills, and attitudes" (Ladson-Billings, 1994 p. 18). Irvine and Armento (2001) describe four attributes of culturally responsive teaching including addressing culture, effective teaching research, reflective practice, and high academic standards. Other terms that have been used to describe this method are culturally

sensitive instruction, culturally congruent pedagogy, and cultural synchronization (Howard, 2001 and Irvine, 2002).

Theoretical Approaches Supportive of CRT

The theories of structural constructivism, sociotransformative constructivism, and cultural anthropology provide support for culturally relevant strategies.

Structural Constructivism

Pierre Bourdieu's theory (Bourdieu & Passeron, 1979) of structural constructivism (developed in the 1960's), a branch of conflict theory, is used to provide the primary structure for this research. "Constructivist pertaining to the dynamic reproduction of human activity in ever-changing contexts; structuralist to refer to the relations of those involved" (Grenfell & James, 1998, p. 13). Much of conflict theory (Marxist) is devoted to the emphasis on the economic structure of society, whereas cultural reproduction theorists, such as Bourdieu, emphasize how culture influences society (Sadovnik, 2001). Figure 2 illustrates the four main concepts of Bourdieu's theory including *habitus, field, capital, and symbolic violence*. An individual's habitus is the predisposition that has developed in response to life experiences. A field is a place which is structured and bounded in terms of common activities (i.e., home or school); however, "no field exists in isolation" (Grenfell & James, 1998). The heart of Bourdieu's theory is the view of society as a market and the concept of cultural capital. There are three products or forms of capital within society including economic, social, and cultural which can be used to "buy" other products in the field. Everyone does not enter a field with equal amounts of capital. Some "possess quantities of relevant capital bestowed on them in the process of

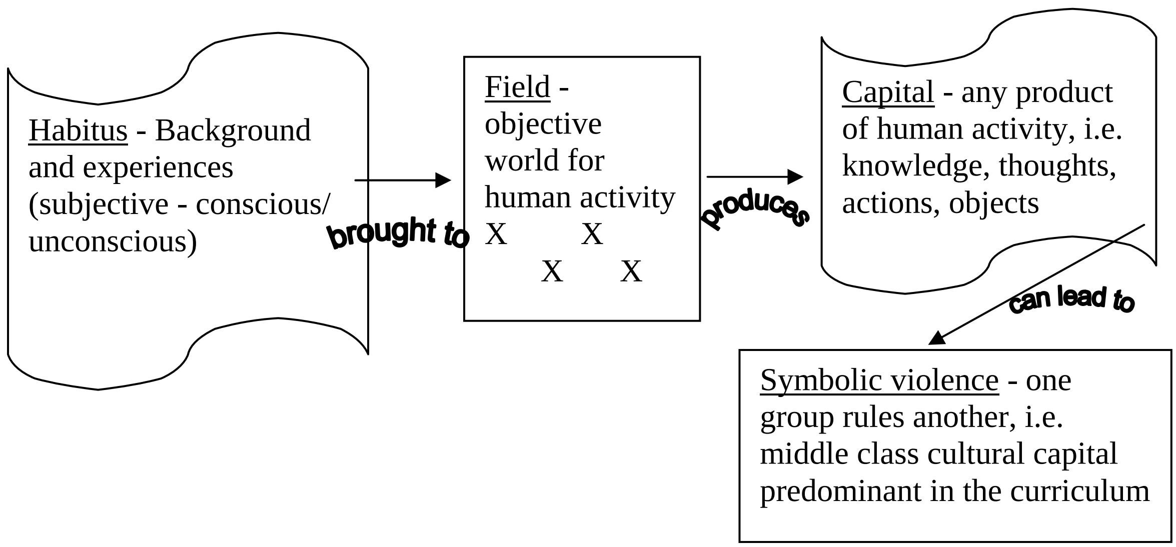


Figure 2. Aspects of Structural Constructivism.

habitus formation, which makes them better players...Conversely, some are disadvantaged" (Grenfell & James, 1998, p. 21). The value of capital is relative to the field in which people are situated. Capital can only have power if it is recognized by other people in the field as important or legitimate.

The main concepts of structural constructivism have several applications in educational research. An individual's education is influenced by the habitus acquired within his/her family situation. An individual's family situation and school environment are both fields of interaction. A student with a habitus that resembles the middle to upper class structure of the school is better suited to succeed within the school and the associated fields beyond the school. However, students do have a choice about their education regardless of the amount of cultural capital they have. "Pupils constantly have

choices about what they do, how they act and think in response to the pedagogic opportunities that are offered" (Grenfell & James, 1998, p. 21).

Symbolic violence occurs in many ways in education. Many individuals recognize the value of knowledge as capital without actually having power themselves. These people are part of the "dominated" class. On the surface, schools appear to meet the needs of all students; however, the cultural capital that lower-class students bring with them to school is often not viewed as valuable within the field.

Bourdieu's theory has been criticized for being a deterministic, closed theory. It is "cynical, pessimistic...eternally doomed to stratification"(Sadovnik, 2001). The closed analogy has also been applied to the term habitus. However, Bourdieu suggested that "people are only rational when they step out of the automatic responses prompted by their habitus" (Grenfell & James, 1998, p. 17). Even though people often cannot control the fields that they are a part of (especially children), they can make choices about how they will use the capital that they have earned and the opportunities provided to them. Furthermore, teachers can provide opportunities for students who are not from the middle class background to use the capital and habitus they have earned as an integral part of the curriculum.

Sociotransformative Constructivism

Rodriguez (1998) describes the sociotransformative constructivist orientation as a theory to encourage learning to teach for "diversity and understanding".

> Learning to teach for diversity implies learning to implement more culturally inclusive and socially relevant pedagogical strategies. Learning to teach for

> understanding involves learning to implement more critically engaging and intellectually meaningful pedagogical strategies. (p. 590)

The components of sociotransformative constructivism (STC) are described by Rodriguez in terms of improving science education and include the dialogic conversation, authentic activity, metacognition, and reflexivity. Although science education was the impetus for STC, it's components are equally applicable to the other school disciplines.

The *dialogic conversation* is one in which each participant understands the content and context of the other participants involved in the conversation. Trust is a critical component due to the presence of power relationships that may hinder/assist the ease with which some people may be willing to expose themselves. *Authentic activity* includes hands-on/minds-on activities that are designed to help students "reflect on how the subject under study is socioculturally relevant and tied to everyday life"(p. 600). Student diversity is considered an asset for the many student-centered activities such as role-playing, group research projects, and concept mapping. *Metacognition* is the "knowledge, awareness and control of one's own learning"(p. 600). Students are shown how to think metacognitively by encouraging them to ask questions of themselves about how they learn and why they are being asked to learn, such as "Can I explain this to someone else?" and "What control do I have in how to proceed?" (p. 600). *Reflexivity* is how one's own social status, beliefs, and education are indicators of what is considered important to learn. Reflexivity encourages, "a discussion of how science knowledge is produced and reproduced, who are (were) recognized as scientists, how their work influences society at large..." (p. 601) as a means of exploring and transforming power relationships.

Cultural Anthropology

Cultural anthropology and sociology have been used to compare a student's life-world or home culture with that of the school culture and describe how the two cultures interact as a student is learning (Jegede & Aikenhead, 1999). Culture is "conceptualized as the norms, values, beliefs, expectations, and conventional actions of a group" (Jegede & Aikenhead, 1999, p. 47). Students experience discrepancies as they compare their life-world culture with that of the school culture (cultural incongruence). "When language or conventional actions of a group have little or no meaning to a person who happens to be immersed in that group and who needs to accomplish some action, the person can experience cultural violence" (Jegede & Aikenhead, 1999, p. 50). This cultural violence is the same as Bourdieu's symbolic violence.

Jegede & Aikenhead (1999) use the concept of border crossing from Giroux (1992) to describe how students travel from their home borders to the borders of school learning. If the transition between borders is smooth the student's life world is not significantly different from that of the school culture and the student will be enculturated. However, a large percentage of students experience conflicts between their home cultures and that of school resulting in attempts to assimilate them. Teachers can act as "culture brokers" to influence students who are experiencing dissonance by assisting them as they cross cultural borders and engaging them with "academic bridges" (Jegede & Aikenhead, 1999, p. 56).

African American Culture & Learning Styles

African American Culture

Culture can be characterized by the statement, "It's the way things are done around here." (Irvine & Armento, 2001, p. 6). The oppression, discrimination, and poverty that African Americans have been subjected to have contributed to the establishment and persistence of their culture (Shade, 1997; Shade, Kelly, & Oberg, 1997). Three attributes of African American (AA) culture noted as African survivalisms include group unity, cooperation, and an interdependence between nature and the individual (Shade, 1997).

Nine psychological dimensions of AA culture include:

1. *spirituality*, an approach that views life as essentially vitalistic rather than mechanistic, with the conviction that nonmaterial forces influence people's everyday lives
2. *harmony*, the notion that one's fate is interrelated with other elements in the scheme of things, such that humankind and nature are harmonically conjoined
3. *movement*, an emphasis on the interweaving of rhythm, percussiveness, music, and dance as central to psychological health
4. *verve*, a propensity for relatively high levels of stimulation and for action that is energetic and lively
5. *affect*, an emphasis on emotions and feelings together with a special sensitivity to emotional cues and a tendency to be emotionally expressive

6. *communalism*, a commitment to social connectedness, which includes an awareness that social bonds and responsibilities transcend individual privileges

7. *expressive individualism*, the cultivation of a distinctive personality and a proclivity for spontaneous and genuine personal expression

8. *oral tradition*, a preference for oral and auditory modes of communication in both speaking and listening are treated as performances in which oral virtuosity - the ability to use alliterative, metaphorically colorful, graphic forms of spoken language - is emphasized and cultivated

9. *social time perspective*, an orientation toward time as passing through a social space rather than a material one, in which time is seen as recurring, personal, and phenomenological (Boykin, 1986, p. 61)

These dimensions are cultivated through a strong kinship system that is typical of the culture. A network of relatives, friends, and neighbors provides "emotional, physical, psychological, and social support" (Shade, 1997, p. 16). The AA home environment is highly dynamic and children are exposed to a variety of creative arts including visual, audio, fashion, and performance (Hale, 2001).

Shade (1997a) and Shade, Kelly, & Oberg (1997) describe AA cultural patterns. AAs' social interaction style preference is to work in groups (originating from the kinship system). AAs are oriented toward people rather than objects as part of their attentional style. From an early age they are taught to be wary of people outside of their kinship system which helps prevent victimization. The perceptual styles of the AA community are multimodal. "Although students like to have oral presentations and oral interactions,

they largely prefer visual and kinesthetic-tactile information" (Shade, Kelly, & Oberg, 1997, p. 70).

African American Learning Styles

"Learning styles are the cognitive, affective, and behavioral ways that individuals perceive, interact with, and respond (with) to learning situations. Many conceptions of learning styles describe them in terms of bipolarity" (Gay, 2000, p. 150). AAs show a preference in their learning style toward "group-ness" in the areas of procedures, motivations, and relationships, primarily because of the emphasis of the AA culture (Gay, 2000). The procedural dimension of a learning style refers to the "preferred ways of approaching and working through learning tasks. e.g., pacing rates, passivity or activity, preference for direct teaching or inquiry and discovery learning" (Gay, 2000, p. 151). The motivational dimension refers to "preferred incentives or stimulations that evoke learning, e.g. individual accomplishment or group well-being, competition or cooperation, conquest or harmony, external rewards or internal desires" (Gay, 2000, p. 152). The relationship dimension refers to "preferred interpersonal and social interaction modes in learning situations. e.g. formality or informality; individual competition or group cooperation, independence or interdependence" (Gay, 2000, p. 152).

AA learning styles are influenced by cultural aspects such as emotions, desire for physical activity, and desire for variability (Guild, 2002; Gay 2000). Their learning seems to be influenced by the: "people with whom they interact in the learning process; the social situation in which the learning occurs; and the degree of relevance and

applicability of the material" (Shade, 1997, p. 23). They have been referred to as field dependent learners. Field dependent learners tend to:

- respond to things in terms of the whole instead of isolated parts;
- prefer inferential reasoning as opposed to deductive or inductive;
- approximate space and numbers rather then adhere to exactness;
- focus on people rather than things;
- be more proficient in nonverbal than verbal communications;
- prefer learning characterized by variation and freedom of movement;
- prefer kinesthetic/active instructional activities;
- prefer evening rather than morning learning;
- choose social over nonsocial cues; and
- proceed from a top-down processing approach rather than a bottom-up approach (Irvine & York, 2001, p. 490)

The Myers Briggs Type Indicator (MBTI) has also been used to identify characteristics of AA learning styles (Melear, 1995; Melear & Alcock, 1999). The MBTI reveals preferences in four categories including extroversion-introversion, sensing-intuition, feeling-thinking, and judging-perceiving. Melear (1995) categorized AA learning style attributes using the MBTI and found differences between AA elementary and high school children that are relevant to science instruction. AA Elementary and middle school students have a strong feeling preference. "The school environment should not become so depersonalized that black children with an F preference get lost…(they need) extra help with school work, compliments on their work, and more

attention from their teachers" (Melear & Alcock, 1999, p. 31). AA high school students have preferences for sensing (S), thinking (T), and perceiving (P). The sensing and thinking preferences are compatible with the nature of science with the focus on details, precision, and logic. However, the perceiving preference can lead to difficulties in school in general because this type has often been regarded as a trouble-maker. "Primarily what teachers can do for P students is to offer options in assignments, processes for completion of activities, and product forms for assignments" (Melear & Alcock, 1999, p. 31).

Characteristics of culture and learning style are overall common trends for a population and there are exceptions to any cultural descriptions within a population. (Ladson-Billings, 2002; Gay, 2000; Shade, Kelly, & Oberg, 1997). Learning styles are

> pedagogically promising to the extent that they illuminate patterns of cultural values and behaviors that influence how children learn, and they provide functional directions for modifying instructional techniques to better meet the academic needs of ethnically diverse students. (Gay, 2000, p. 147)

The cultural and learning style traits described for AAs should be considered "modal personality" traits and great care should be taken to avoid creating stereotypes. "When we speak of the modal personality or style of a group, we are referring to traits that are most likely to be found in a sample of the population" (Shade, Kelly, & Oberg, 1997, p. 21).

What this Means for Teachers

> The relationship of the values of the culture in which a child is currently living, or from which a child has roots, and the learning expectations and experiences in the classroom are directly related to the child's success academically, socially, and emotionally. A deep understanding of both culture and learning style differences is important for all educators, although the subject must be addressed carefully. (Guild, 2002, p. 103)

Murrell (2002) describes the term pedagogy as "teaching and learning as it is grounded in human experience and history" rather than as "the application of the latest educational theory, techniques, or research findings" (p. xxxii). This definition of pedagogy is useful when referring to Culturally Relevant Teaching (CRT) practices. "Culturally relevant pedagogy has attempted to locate the problem of discontinuity between what students experience at home and what they experience at school in the speech and language interactions of teachers and students" (Ladson-Billings, 2002, p. 96). Villegas & Lucas (2002) claim that teachers who have developed an affirming attitude toward students from culturally diverse backgrounds see the differences that students hold as assets rather than problems to overcome. They provide a challenging curriculum, teach strategies to allow students to monitor their own learning, hold high expectations and hold students accountable to them, and encourage students to do their best. Despite the extensive research that has been documented on the culture and learning styles of students of color, not all learning styles are equally valued in schools (Guild, 2002).

Banks et al. (2001) have several suggestions for student learning. The learning environment should maximize the ability for all students to learn by including: quality teachers, safety, constructive on-task behavior, low student to teacher ratio, a rigorous curriculum, avoidance of tracking, updated technology and learning materials, and access to extracurricular activities. Hale (2001) claims that schools need to provide cultural enrichment activities for AA students, such as conflict resolution, teen pregnancy prevention, male mentoring, and tutoring because they often do not come to school with, "the social training needed to interact positively with fellow students and teachers" (p. xxiii).

Suggestions for Teaching AA Students

Villegas & Lucas (2002) claim that CRT requires that teachers understand how learners construct knowledge and are capable of promoting knowledge construction. Constructivism promotes critical thinking and acknowledges that the information that students bring with them to the classroom is influenced by their cultural and personal experiences. Some specific teaching strategies for AA responsive classrooms include:

1. Enable students to recognize and affirm their collective identification.
2. Give students enhanced sense of mutual responsibility for their own learning and the learning of their peers for benefit of community, society, and humanity.
3. Include humanistic and personally meaningful curriculum in all areas particularly from the African American cultural ethos such as proverbial wisdom, metaphoric language, orality, public performance, and artistic expression.

4. Assist students to recognize and maintain the cultural values and style of the African American community. Children must discover, understand, and use the strengths of their cultural patterns in the teaching-learning process.

5. Involve students in critical thinking and inquiry, particularly around the strengths, weaknesses, and difficulties facing their community and society.

(Shade, Kelly, & Oberg, 1997, p. 88-89)

The use of learning styles and culture research enables a teacher to draw upon the particular strengths of individuals within the classroom (Educational Research Service, 2003). When teachers are unfamiliar with the cultural background of students, miscommunication is inevitable including: "confrontations between the student, the teacher, and the home; hostility; alienation; diminished self-esteem; and eventual school failure" (Irvine & Armento, 2001, p. 7). Several researchers recommend the use of movement, small group work, alternative strategies (such as inquiry and cooperative learning, listening to music while working), culturally connected strategies (such as call and response and affirmations), and alternative assessments (such as performances) to increase the motivation and achievement levels of AAs (Hale, 2001; Irvine & York, 2001; McElroy & Hollins, 1999; Shade, Kelly & Oberg, 1997).

Culturally relevant teaching approaches place the responsibility for student success and learning with the teacher rather than placing blame on students or families (Hale, 2001; Irvine & York, 2001). "The teacher of culturally diverse students becomes the cultural liaison and has the responsibility for developing a connection between the culture of the students and the culture of the school" (Shade, Kelly, & Oberg, 1997, p. 19). Students come to school with skills that have been successful for them in their home

environments and teachers need to find ways to cultivate these skills and use them "as scaffolds or bridges to academic achievement" rather than view them as deficits (Gay, 2000, p. 175). A teaching approach suggested for use with AA students, described by Shade, Kelly, & Oberg (1997, p. 94), includes: a structured classroom; work completed in small groups rather than alone; an extensive use of problem-solving and discovery methods; and a teacher that is warm, encouraging, and sensitive to the social/emotional context of the classroom and a consistent disciplinarian.

Section Summary

Culturally relevant teaching (CRT) practices guided by the theories of structural constructivism, sociotransformative constructivism, and cultural anthropology acknowledge the differences that are often held between students and their teachers and provide a method to bridge those differences. CRT practices rely, to a small part, upon teachers becoming literate in specific teaching strategies. However, it is more important for teachers to become literate consumers of their students' lives and communities as a precursor to developing lesson plans. It is common to expect teachers to make informed decisions regarding teaching based upon the individual needs of students, but many teachers focus only on the background of students within schools (i.e., test scores and behaviors) and neglect the life of students in their own communities and homes, their specific cultures, and their predominant learning styles.

Culturally relevant teaching practices require that teachers have the skills, knowledge, and dispositions to teach diverse students who are culturally different, not culturally deficient. CRT involves more than teaching about the contributions of various ethnic groups to our society. CRT is teaching for diversity and understanding as it is

grounded in students' everyday experiences. Acknowledging and using the students' life-worlds, cultures, and learning styles as part of the school curriculum validates the habitus and cultural capital that students bring with them.

Inquiry-Based Professional Development

General Suggestions

Inquiry-based professional development (PD) programs influence inservice teachers as they are immersed in authentic inquiry-based experiences (Loucks-Horsley, Hewson, Love, & Stiles, 1998. The *NSES* (NRC, 1996) describe standards for effective PD programs for science teachers who have a professional responsibility to seek these opportunities throughout their careers. These standards are learning science content through inquiry, learning to teach science through inquiry, learning skills and attitudes to become lifelong learners, and participation in comprehensive professional development programs that integrate teaching and learning. Empirical evidence has been collected over the past decade supporting each of the *NSES* guidelines.

Numerous studies have actively engaged teachers by immersing them in PD program that allowed them to construct their own knowledge regarding science content and inquiry practices (Kahle, Meece, & Scantlebury, 2000; Lederman et al., 2003; Luft, 2001; Maor, 1999; Radford & Ramsey, 1996). A typical format for these programs is to engage teachers in intensive summer institutes in which they practice inquiry methods, attend workshops that promote reflection and extensions during the school year, and implement inquiry-based practices and receive feedback from program staff. These PD opportunities use a constructivist philosophy by building on the current understandings and beliefs of teachers in order to foster change in the classroom.

Maor (1999) stressed the importance of providing follow-up guidance for using the skills acquired as part of professional development efforts. Teachers need to know how to use the tools (computers, software, lab equipment) and have opportunities to work with their peers to improve confidence in transferring these skills to students. Teachers are able to have a better understanding of what students experience as learners when researchers model inquiry-based practices for them (Batista, Tomlin, Pennington, & Pugh, 2001). Characteristics of learning through inquiry are active investigation; introducing participants to scientific literature, media, and technology; ongoing reflection; and collaboration (NRC, 1996).

PD programs need to offer teachers opportunities to experience inquiry and train them to transfer that knowledge into pedagogical teaching skills. Pedagogical content knowledge includes knowledge about content, the needs of learners, and how students learn most effectively (NRC, 2000b). Roseberry and Puttick (1998) describe a PD opportunity in which teachers learned from each other by watching videotapes of selected inquiry activities. Feedback from peers can help direct instructional practices. Luft (2001) suggested several methods for providing transformative feedback including electronic communication, evaluations, observations of instructional practices, and participation in workshops.

PD programs should provide assistance to teachers over an extended period of time, they should include the collaboration of science educators and scientists, and they should include a commitment to the reform efforts established in the *NSES* (NRC, 1996). The contact time should be spread out to allow teachers to implement and reflect upon strategies with their own students. In addition, these teachers should be encouraged to

conduct workshops and to present what they have learned at conferences as a continuation of their PD (Radford & Ramsey, 1996).

Emphasis on Mentoring Teachers

Both new and experienced science teachers can be encouraged to stay in the profession with the support of mentoring programs offered as a method of PD. Induction programs that emphasize mentoring new teachers are becoming popular methods to increase teacher satisfaction and the retention rate (Easley, 2000; McCreight, 2000; and Rhoton & Bowers, 2003). As new science teachers are inducted into the profession, they are often overwhelmed due to the pressures of teaching (Adams & Krockover, 1999; Mulholland & Wallace, 2001). Novice teachers, particularly at the elementary level, have difficulties teaching science due to a "school culture apathetic to science and (a) barely adequate knowledge of science content and pedagogy" (Mulholland & Wallace, 2001, p. 244).

Program 1 - Milwaukee Urban Systemic Initiative in Math and Science

The Milwaukee Urban Systemic Initiative in Math and Science, which was initiated in 1997, employed K-12 math and science teachers within Milwaukee Public Schools (MPS) to become Mathematics/Science Resource Teachers (MSRTs). The primary function of MSRTs was "to support effective teaching and learning in MPS through the implementation of content-rich, inquiry-based science and mathematics curriculum, instruction, and assessment," within assigned schools (Staten, 1998, p. 2). MSRTs were to accomplish this support through dialogue, modeling, team teaching, peer coaching, and mentoring. Staten (1998), who was a practicing MSRT, conducted action research to determine the effectiveness of this program for science instruction. Data

sources included two classroom observations of MSRTs demonstrating I-B lessons, four observations of PD opportunities coordinated by MSRTs, and analysis of four focus group discussions with MSRTs. An observation tool developed from a comprehensive review of literature regarding I-B instruction was used to analyze the aspects of inquiry present in the classroom and professional development observations. Analysis of the MSRTs' classroom demonstrations and professional development workshops revealed that they were "experiential and inquiry-based in nature;" however, the teaching was more traditional than constructivist-based (p. 27). It was concluded that MSRTs needed a common and accurate understanding of I-B instruction in order for them to be effective leaders. The focus group discussions yielded suggestions that were used to design a framework for improving the preparation of MSRTs as well as supporting all teachers in the implementation of I-B instruction.

The framework included: designing and using I-B *curriculum, instruction, and assessment*; *professional development* that provides opportunities for teachers to experience and reflect on I-B learning; *collaboration* among teachers who plan and teach with others and provide opportunities to observe each other's teaching; *professional discourse* regarding I-B implementation, student artifacts, reading, and action research; *networking* through study groups, electronic communication, and joining professional organizations; support from a *lead teacher* mentor who coordinates I-BPD and instruction within a school; *administrative support* by providing time and materials for planning I-B instruction and a safe environment for experimentation; and establishing a *learning community* of informed stakeholders including parents, community members, and policymakers. It was also suggested that teachers could be trained to use the

observation tool established through this research as a reference for planning and teaching I-B lessons.

Program 2 - Teacher Support Specialist in Science

Upson, Koballa, and Gerber (2002) described a collaborative program among three Georgia Universities called the Teacher Support Specialist in Science (TS^3). The program goal was to prepare science-specific mentors by providing 50 hours of coursework during a summer session in which the objectives were:

> to demonstrate and discuss the critical attributes of effective science teaching practice; to demonstrate skills in collecting and analyzing classroom observational data and in providing feedback; to develop effective interpersonal skills in conferencing situations; to discuss and demonstrate principles of adult learning and reflective teaching; and to develop a calendar of activities to facilitate the professional development of a protégé. (p. 3)

The participants learned about conceptual change theory and inquiry through discussions of and participation in inquiry-based labs during the summer session. During the fall semester, the participants mentored a protégé within their school for 50 contact hours using the knowledge gained in the summer portion.

Thirteen participants (six middle and seven high school teachers) are described who completed the experience. Participants found the program a positive experience and a worthwhile form of professional development; they learned strategies and felt supported from having access to fellow mentors through e-mail and direct contact; and they improved their own teaching practices through the process of preparing to mentor protégés.

Emphasis on Examining Beliefs and Practices of Teachers

Teachers who have had opportunities to experience inquiry as part of PD workshops have credited the experience for changing their practices. Program 1, the Salish I Research Project (1997), was not a PD program; however, it revealed some valuable insights for the PD of novice teachers. Five quality PD programs are described including the Inquiry-Based Demonstration Classroom (Luft, 2001), Project LIFE: Laboratory Investigations and Field Experiences (Radford & Ramsey, 1996), Project ICAN: Inquiry, Context, and Nature of Science (Lederman, et al., 2003), Project START: Science Teachers and Reformed Teaching (Austin, et al., 2003) and the Ohio Statewide Systemic Initiative (Kahle, Meece, & Scantlebury, 2000). As described in the previous section, mentoring and coaching other teachers to use I-B instruction was one of the goals of several of these projects. This section concludes with a comprehensive examination of Local Systemic Change Initiatives that were in place by 1997 (Supovitz and Turner, 1998).

Program 1 - Salish I Research Project

The Salish I Research Project, a three-year collaborative among nine university sites, followed teachers that completed their preservice education programs, that advocated constructivist, I-B practices, into the first three years of teaching (Salish I Research Collaborative, 1997; Simmons, et al., 1999). They found that the impact of a preservice program may not be evident until after the teachers have survived the first two to three years of teaching experience. The Salish Project used numerous research instruments including the Secondary Teacher Analysis Matrix (STAM), the TPPI, and the Constructivist Learning Environment Survey (CLES) to determine the teachers' practices

and beliefs on a continuum between didactic (teacher-centered) and constructivist (student-centered). They found these teachers held student-centered beliefs and described their practices as student-centered; however, from direct observations of teaching using the STAM instrument, the researchers found their behaviors were actually teacher-centered. Furthermore, when a novice teacher was asked to use the STAM instrument to evaluate his own teaching, he credited the process with redirecting his teaching to constructivist methods that were taught in his preservice program (Adams & Krockover, 1999). Adams & Krockover (1999) developed three assertions regarding the use of the STAM as an instrument for change:

1. The STAM provides a heuristic for teachers to reconstrue their teaching style
2. The STAM stimulates recall of program experiences to aid in reconstruing of teaching style
3. There is a time-critical component with the use of devices such as STAM (p. 967-968)

Regarding the last assertion, the researchers suggested that during the first three years of teaching (the survival years), teachers have many concerns about the process of teaching (i.e., classroom management) and duties beyond the classroom. Teachers may not be ready to implement constructivist strategies until after this "survival" period. Findings from this research support the use of PD to guide new teachers in developing and maintaining constructivist behaviors during their induction years (Adams & Krockover, 1999; Simmons, et al., 1999).

Program 2 - Inquiry-Based Demonstration Classroom

Luft (2001) found that the beliefs of novice teachers are more easily manipulated than those of experienced teachers and that PD is often helpful to encourage novice teachers to adopt inquiry-based teaching practices. Fourteen novice (n=6) and experienced (n=8) science teachers participated in PD workshops, known as the Inquiry-Based Demonstration Classroom, designed to introduce them to and provide experiences with I-B learning during the Spring and Summer. Each participant was provided with follow-up opportunities during the school year including classroom observations and feedback regarding inquiry-based lessons, additional one-day workshops (topics: cooperative learning, alternative assessment, etc.) and electronic communications with each other and staff. Among the data sources collected pre and post PD were field observations, eight questions from the Teacher's Pedagogical Philosophy Interview (TPPI), and questions about definitions of and experiences with inquiry. "The induction teachers experienced more change in their beliefs than their practices, whereas experienced teachers demonstrated more change in their practices than their beliefs" (p. 531).

I-BPD benefits experienced teachers who often believe that I-B practices are appropriate but do not know how to implement these methods. Luft recommended providing PD to new and experienced teachers concurrently in order to help teachers with different backgrounds learn how to work with each other to change their practices over time. Additional findings included: "participants replaced general views of inquiry instruction with specific science-related inquiry tenets as articulated in the *National science education standards*" (p. 528); "they learned instructional techniques that could

be used in different settings, and they felt inspired to plan and enact additional inquiry lessons" (p. 529); and "While participants' beliefs may have directed their inquiry practices, their inquiry practices did not noticeably affect their beliefs. The lack of change in participants' beliefs may be attributed to the stable nature of beliefs" (p. 530).

Program 3 - Project LIFE: Laboratory Investigations and Field Experiences

Radford and Ramsey (1996) described a program called Project LIFE: Laboratory Investigations and Field Experiences that was part of the Louisiana Statewide Systemic Initiative Program (sponsored by NSF). There were four components to the program including: a three-week summer course in which teachers participated in I-B learning experiences; a four-week independent science research project that teachers presented at the state science teachers' conference; follow-up with course instructors during the school year with classroom visits and five, all-day workshops; and participation in a leadership institute in which selected participants were trained to conduct future workshops and to mentor other teachers within their school and district. Participants recorded observations and reflections throughout the experience.

Project staff included a science educator, two scientists (a biologist and chemist), and an exemplary middle school teacher as an effort to represent both a solid understanding of scientific processes and an understanding of pedagogical techniques. Teacher participants consisted of 90 - upper elementary, middle, and high school teachers over a 3-year period (30 per year). As a result of course participation, teachers were shown to have improved: their content knowledge (as measured by a multiple choice test created by project staff); science process skills (as measured by the Middle Grades Integrated Process Skills Test - MIPT); and attitudes toward science (as measured by a

survey created by project staff). Students selected from classrooms of teachers from Project LIFE and non-Project LIFE classrooms completed the MIPT and science attitude surveys as well. Students of Project LIFE teachers: were more likely to use the "language of science" in response to survey questions; were more likely to discuss the importance of "working in collaborative groups and discussing scientific ideas;" and "did not feel that they were performing steps to find an answer predetermined by the teacher, but rather felt they were engaged in a collaborative attempt to answer a question" (p. 10). Teachers credited the course with helping them begin to "really understand science which is a prerequisite to helping students understand science" (p. 10). Project staff concluded that teachers must first experience I-B learning before they can be expected to teach with I-B instruction.

Program 4 - Project ICAN: Inquiry, Context, and Nature of Science

Lederman et al. (2003) described an NSF-funded teacher enhancement program called Project ICAN: Inquiry, Context, and Nature of Science. Project ICAN provided I-BPD with a specific emphasis on enhancing middle and high school teachers' understandings of the NOS with the aim of improving their students' understanding of the NOS and ability to perform I-B science. Fifty teachers that participated in the second year of this project are the focus of the study. The emphasized aspects of the NOS were science knowledge as tentative, empirical, subjective, creative, and a distinction between observation and inference.

Three phases of Project ICAN included ten, full-day monthly workshops during the academic year, a two-week summer institute, and follow-up activities during the next academic year. The first phase provided opportunities for participants to: revise and

implement lesson plans to include I-B activities and an explicit discussion of the relevant NOS issues, "within the context of traditional science subject matter;" observe videotaped sessions of each participant's teaching of these lessons and provide support and feedback for instruction; and actively engage in I-B and NOS activities (Lederman, et al., 2003, p. 6). Before the summer phase, the participants engaged in either an internship with a practicing scientist or an internship within an informal setting such as a museum or zoo in order to experience inquiry and the NOS within an authentic context. The second phase of Project ICAN, the two-week summer institute, consisted of 10, six-hour sessions. They engaged in "explicit/reflective activities, readings, and discussions" with the main focus on the "development of performance-based assessments for scientific inquiry and the nature of science" (p.7). During the third phase, which consisted of follow-up during the academic year, the teachers incorporated their revised instruction and assessment techniques within their classrooms. Participants videotaped one lesson per month and provided student artifacts for project staff to review and for which to provide feedback. Project staff also made direct observations of teaching in order to provide support and feedback.

Data sources used by project staff to evaluate the program included: the Views of Nature of Science (VNOS-D) and Views of Scientific Inquiry (VOSI) questionnaires, interviews with a representative sample of ten teachers, journal reflections, videotapes, lesson plans and assessment activities, classroom observations, and student views as measured by the VNOS-D and VOSI questionnaires (1500 students). The teachers improved their understanding and use of I-B instruction and NOS. Participants who held informed views of: the tentative NOS improved from 19% to 42%; the empirical NOS

improved from 26% to 45%; the creative NOS improved from 10% to 40%; the subjective NOS improved from 19% to 35%; and the distinction between observation and inference improved from 32% to 50%. The teachers also improved their understanding of scientific inquiry with an increased understanding of multiple methods used to investigate scientific questions; multiple interpretations given to a set of data; and supporting conclusions with evidence. Most of the teachers were able to discuss with students the inferential, empirical, and creative aspects of the NOS (also shown to be the greatest changes in students' views of the NOS); however, they felt there were a lack of examples of the tentative and subjective aspects of the NOS as part of classroom investigations. While 70% of the teachers showed major changes in their views of scientific inquiry, only 35% of their students did so. This was attributed to the use of "simplistic inquiries where one general conclusion is likely" (p. 19). Project ICAN staff concluded that, "peer group support and interaction in the monthly workshops proved to be an integral factor in teachers' development of PCK (pedagogical content knowledge) for NOS and SI (scientific inquiry) (p. 19).

Program 5 - Project START - Science Teachers and Reformed Teaching

Project START was designed initially as a three-year PD program funded by Eisenhower Teacher Quality Enhancement funds in Arizona; however, due to the ending of Eisenhower funding, years two and three were compressed into the second year (Austin, et al., 2003). The goal of Project START was to prepare teachers to plan and conduct I-BPD programs for other teachers. The first year of Project START incorporated a two-week summer workshop in which participants (14 middle and high school teachers): practiced different I-B instructional models; read and discussed

constructivist-based articles; examined standards documents including *NSES*, *Benchmarks*, and state standards; and discussed effective practice such as incorporating NOS, cooperative learning, and action research. Follow-up activities during the academic year included classroom observations and feedback from project staff, monthly meetings, and attendance at the state science teachers' convention. In year two, called Project START 2, five of the 14 teachers continued the program and participated in leadership training and designed a one-week inservice program for other teachers within their schools and district. The teachers that continued with the second year of the program read the literature base that informed the project staff in developing Project START.

From the teachers' perspectives, some of the positive aspects of START and START 2 were:

> teachers of varying levels of experience; in-depth discussions and use of inquiry models gave teachers a common language; some teachers were able to transfer knowledge to their own students in the classrooms; meetings throughout the year gave support; and experience of teachers ... motivated those who were just beginning to use inquiry in their classrooms. (p. 11-12).

The challenges of START were:

> lack of district support (district administrators are not knowledgeable about inquiry); initial rapport between some teachers didn't carry over into the year; demands on time; some teachers didn't buy in to furthering their inquiry-based teaching practices. (p. 11-12)

The challenges of START 2 were:

> meeting the needs of high school teachers... management issues, number of students, and amount of content to be covered; length of workshop not conducive to giving teachers opportunities to learn about, try, reflect and share information on inquiry; restricted by time constraints and money; inconsistent attendance throughout the year in support meetings; lack of support personnel (to conduct) observations and support teachers in terms of feedback sessions and help with planning etc., not available as available in START. (p. 12-13)

Program 6 - Ohio Statewide Systemic Initiative

Kahle, Meece, & Scantlebury (2000) have found that student achievement has improved after implementing inquiry-based methods and found improvements were consistent across socioeconomic levels and races. They studied the results of Ohio's Statewide Systemic Initiative (1994-1999) sponsored by the National Science Foundation to improve mathematics and science instruction. This study and its results have been described in the *Teaching Accountability and Inquiry* section at the middle-school to secondary level of this Chapter.

Local Systemic Change Initiatives - Comprehensive Examination

Supovitz & Turner (1998) completed a comprehensive examination of 24 of the NSF-funded, Local Systemic Change Initiatives that were in place in 1997 with a K-8, PD-focus on science. They surveyed 3,464 teachers and 666 principals in an effort to determine teachers' investigative practices and classroom culture of investigation. A teacher's *investigative practices* was a measure of their use of I-B practices with

questions about the frequency of having students, "engage in hands-on activities; design or implement their own investigation; write reflections in a notebook or journal; and work on extended science investigations or projects" (Supovitz & Turner, 1998, p. 969). A teacher's *classroom culture* of investigation was a measure of strategies used when teaching science such as, "arrange seating to facilitate student discussion; require students to supply evidence to support their claims; encourage students to explain concepts to one another; and have students work in cooperative groups" (Supovitz & Turner, 1998, p. 969).

They found that it was more difficult to change classroom culture than investigative practices. Eighty hours of PD was found to be necessary for significant changes in the use of inquiry-based (I-B) teaching practices; whereas, major changes in classroom culture were not evident until after 160 hours of PD. Individual, school-level, and community influences on investigative practices and classroom culture were noted. The largest influences at the individual level were the amount of content preparation and attitudes toward reform. "The effect of content preparation on practice was the same regardless of the intensity of teachers' professional development experiences" (p. 974). Positive attitudes toward reform led to more inquiry-based practices and positive classroom culture. Influences at the school-level were principal support, available resources, and poverty level. Teachers who felt supported by the principal showed a greater use of reform strategies. Instructional practices were influenced when necessary resources were available; however, no significant impact was made on classroom culture. As the number of students at the poverty level (as measured by the percentage on lunch assistance) increased so did the incidence of traditional science practices. The type of

community (urban, suburban, or rural) that the school was located in did not have a significant influence on teachers' practices or classroom culture.

Section Summary

Inquiry-based professional development programs immerse teachers in authentic inquiry-based experiences. The *NSES* (NRC, 1996) describe effective professional development programs for science teachers including learning science content through inquiry, learning to teach science through inquiry, learning skills and attitudes to become lifelong learners, and participation in comprehensive professional development programs that integrate teaching and learning. Numerous programs were described which followed these guidelines.

Chapter Summary

This chapter has described aspects of scientific literacy including inquiry and the Nature of Science. Scientific inquiry is a constructivist method that many teachers have not had experiences with. In order for instruction to be culturally relevant, a variety of teaching strategies must be used within the classroom to address the students' learning styles and cultures. Teachers who have had the opportunity to experience inquiry will be more likely to implement the strategy within the classroom. Inquiry-based instruction that allows students to develop their own questions about content acknowledges the individual strengths and capital that students bring from their home lives. Professional development can provide teachers with the necessary skills and personal experiences to implement inquiry-based methods in their classrooms and to mentor other teachers in these practices. Inquiry-based instruction is a culturally relevant teaching strategy that is

appropriate to use with African American students. Urban students have been shown to excel academically using inquiry-based science instruction.

Figure 3 summarizes the theories of structural constructivism, sociotransformative constructivism, and cultural anthropology. Figure 4 displays the positive outcomes of recognizing these theories and their linkage with culturally relevant teaching and inquiry. Figure 4 also reveals the negative consequences that may occur when these theories are ignored.

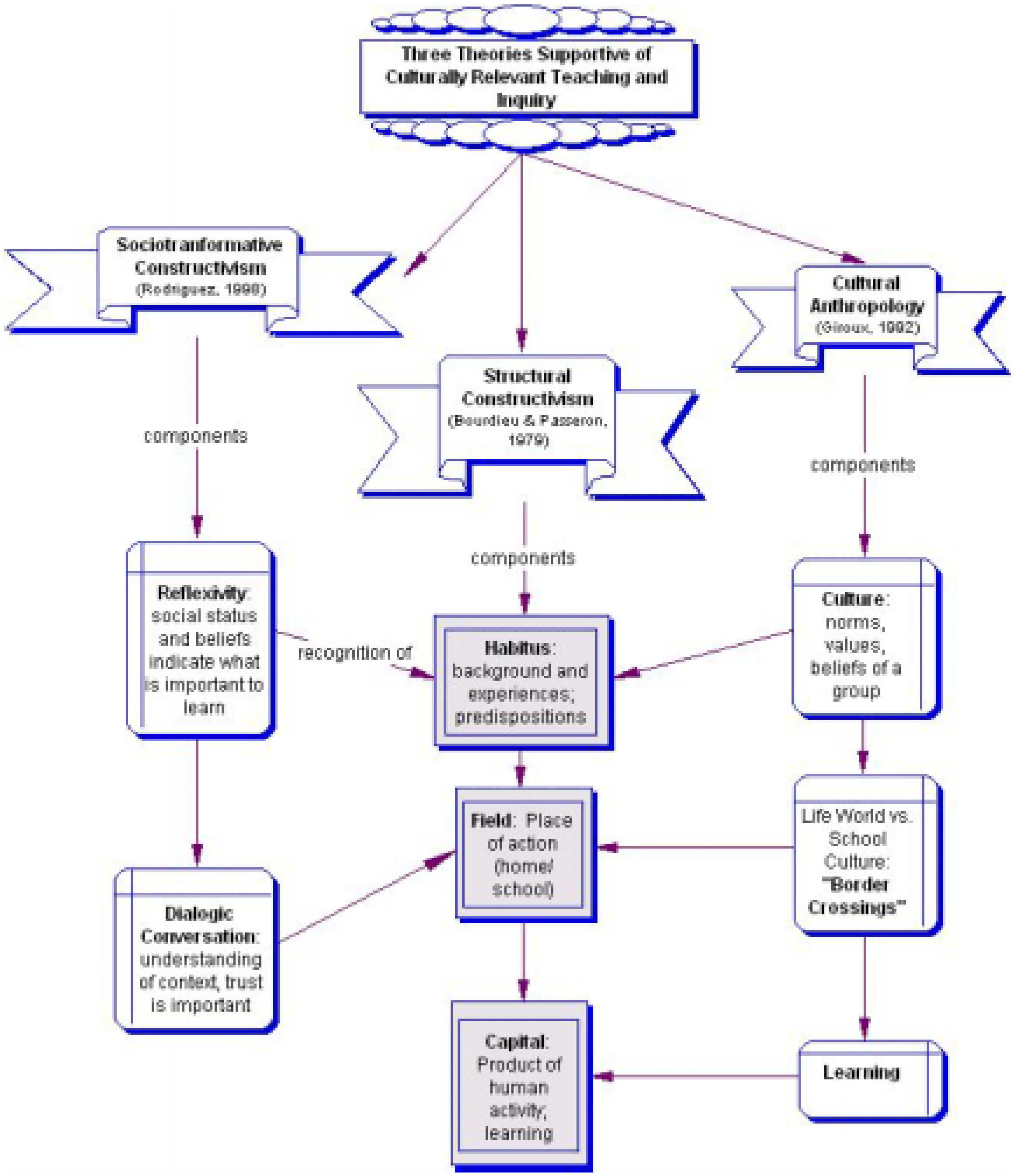


Figure 3. Three Theories Supportive of CRT and Inquiry.

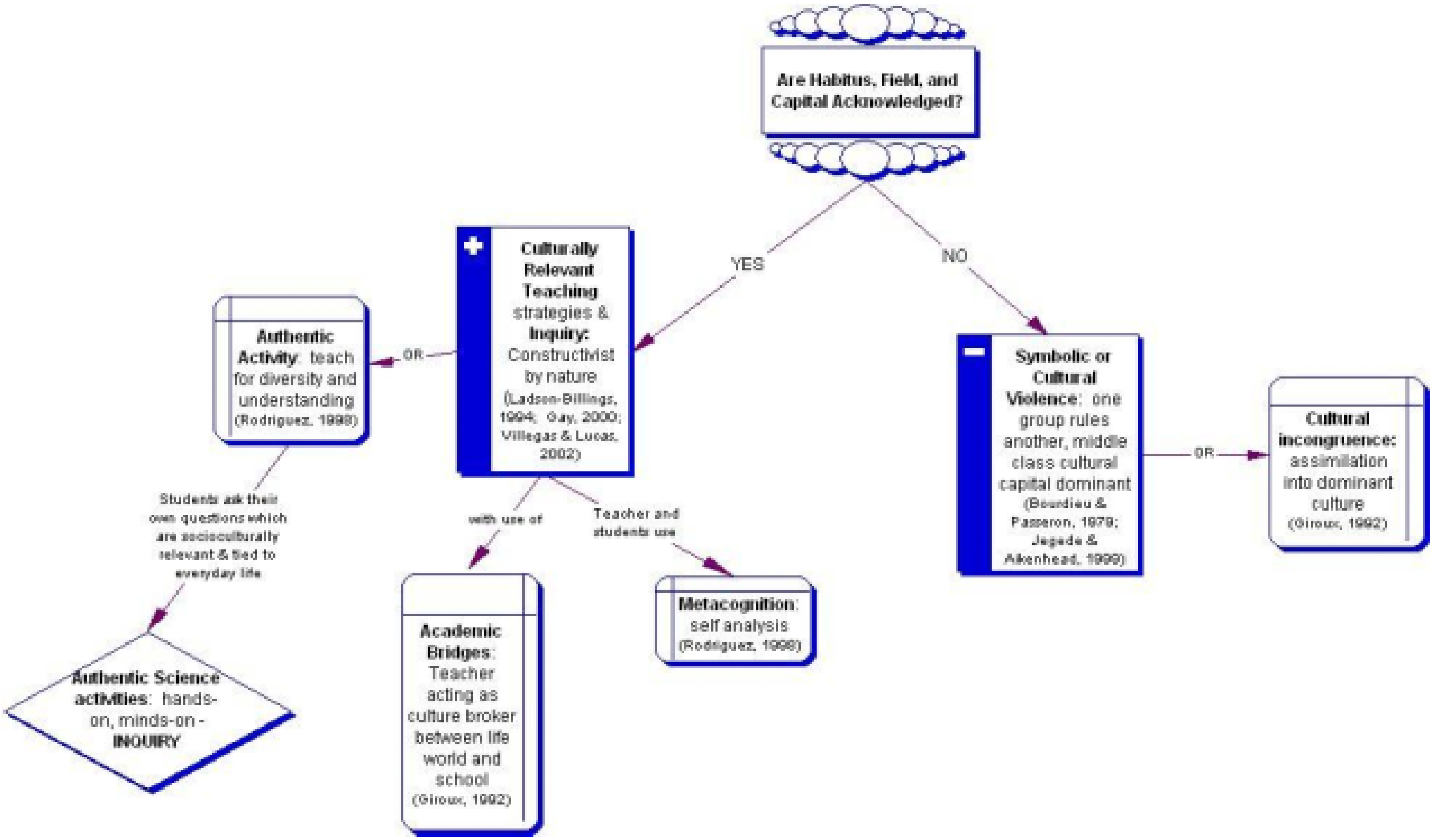


Figure 4. Habitus, Field, & Capital: Acknowledged or Not Acknowledged.

CHAPTER III: METHODOLOGY

This chapter addresses the rationale and utilization of a collective case study approach to frame the research. Information concerning the rationale for this methodology, participant selection, description of the course, and instruments used for data collection are addressed under the following headings:

(1) Rationale and Collective Case Study Methodology

(2) Course Background and Description

(3) Identification of Cases

(4) Question/Instrumentation Alignment

(5) Data Analysis

(6) Summary

Rationale and Collective Case Study Methodology

The context of research with the small number of participants of the Project INQUIRE course leant itself to qualitative research. Qualitative research is "any systematic investigation that attempts to understand the meanings that things have for individuals from their own perspectives" (Singletary, 1994). Studies in science education have traditionally "ignored the meanings that participants in a study bring to the experience rather than viewing those meanings as integral to the experience" (Simmons et al., 1999). Meanings are complex in that they are unique, shared, constantly changing, subjective, contextual, and created through interaction in our world.

A collective case study methodology was chosen for this study. "A case study is an exploration of a "bounded system" or a case (or multiple cases) over time through detailed, in-depth data collection involving multiple sources of information rich in

context"(Creswell, 1998, p. 61). The "bounded system" for this research was participation in the Project INQUIRE course over a 7-month period. This was a collective case study because multiple cases, or participant's views, were analyzed. Multiple sources of information are collected because a case study requires extensive verification, or triangulation, to provide a detailed picture of each case (Stake, 1995). "Any finding or conclusion in a case study is likely to be much more convincing and accurate if it is based on several different sources of information, following a corroboratory mode"(Yin, 1994, p. 92). Multiple data sources were used for "data triangulation" (Yin, 1994) in order to understand the impact of the Project INQUIRE course for participants. These sources included direct observations of teaching, interviews, participant reflections, and questionnaires. While multiple sources are used in a case study one or two sources of data collection predominate and the others play a supporting role (Merriam, 1988). The predominate methods relied upon in this research were observations and interviews. "Member checking" (Stake, 1995) was used when the participants were given transcripts of their interviews and observations to examine after data collection occurred.

Creswell (1998) suggests a typical format for collective case studies. A thick description of the Project INQUIRE course provides the setting for the cases. Within-case analysis provides a detailed description of themes or assertions found through the study of each participant or case. Within-case analysis is followed by cross-case analysis which "involves examining themes across cases to discern themes that are common to all cases" (Creswell, 1998, p. 250). The final phase, which is interpretive, examines "the lessons learned from the case(s)" (Creswell, 1998, p. 63).

Course Background and Description

The Project INQUIRE course was developed by adapting a pre-existing course originally designed for preservice teachers. "Knowing and Teaching Science: Just Do It" ("Do It") was initiated in 1997 within the botany department at the University of Tennessee to allow pre-service biology majors to participate in inquiry-based research experiences (Hickok, Warne, Baxter, & Melear, 1998; Melear, 2000; Melear, Goodlaxson, Warne, & Hickok, 2000). The theoretical foundations for designing the "Do It" course included immersion, the apprenticeship model for instruction, social constructivism, and situated cognition (Duit & Treagust, 1998; Farnham-Diggory, 1994; Lave & Wenger, 1991; Melear, 2000; Prawat, 1991). These foundations are also descriptive of the Project INQUIRE course. Teachers are immersed in the culture of science by conducting scientific research for a prolonged period in a lab. "Science can be considered as a culture, which can be learned best in the environment of members of that culture" (Melear, 2000, p. 7). The apprenticeship model for learning is the acculturation into the world of the expert. The actual participation in the world of the expert is an important criterion to allow the expert to transmit knowledge to the novice that changes with different contexts (Farnham-Diggory, 1994). Social constructivism and situated cognition can be used to describe how knowledge can be constructed through social interactions (Duit & Treagust, 1998; Lave & Wenger, 1991; Melear, 2000). The inquiry-based experiences provided within the "Do-It" and the Project INQUIRE courses are expected to better prepare teachers to teach using constructivist, inquiry-based strategies.

The "Do-It" course has been the subject of several research studies. Lashley (2002) completed a qualitative study of the experiences of the scientist instructor,

outlining the transformation from a didactic to a constructivist teaching style. Lunsford (2002) described the use of inscription notebooks as part of the "Do-It" course as a means to provide authentic science instruction and assessment.

Two additional research studies provided the basis for the need for the Project INQUIRE course. Suters, Melear, & Hickok (2002) interviewed eight teachers within their first three years of teaching who had taken the "Do-It" course as preservice teachers. The teachers expressed student-centered views of their teaching; however, they presented constraints with teaching by inquiry. Among these constraints included being a novice teacher, difficulty finding others who teach using the inquiry-based style, unfamiliarity with content (teaching chemistry when certified for biology), and the time constraints of teaching (meeting curriculum requirements for standardized testing). Brown (2002) also interviewed eight teachers (two of the same participants as Suters et al. 2000) within their first three years of teaching who had taken the "Do-It" course as preservice teachers; however, she also completed classroom observations. Approximately six of these eight teachers professed and exhibited a teacher-centered style of teaching. Although the teachers in both studies were exposed to inquiry-based experiences as preservice teachers, the majority were using teacher-centered practices as their primary method of teaching. The Project INQUIRE course was initiated in response to these findings. The goal was to provide inservice teachers with inquiry-based experiences so they would be better prepared to teach using these methods and better prepared to mentor novice teachers to use these practices when they enter the teaching field.

The Project INQUIRE course attended to the principles of effective professional development for science teachers as outlined by the *NSES* (1996). Participants learned

science content through inquiry, learned to teach science through inquiry, learned skills and attitudes to become lifelong learners, and participated in a comprehensive professional development program that integrated teaching and learning. The course provided 50 contact hours (and three hours of graduate credit in Botany) with participants over a seven-month period spanning the spring, summer, and fall semesters (see Appendix A for syllabus). The instructors of the course were a botany professor and a graduate teaching assistant (science education doctoral student). In addition to the five inservice teachers included in this study, two preservice secondary science teachers and one science education doctoral student took the course.

The spring semester portion of the course consisted of three, three- hour sessions in April and May, 2003 held at the county's Teacher Center. During the first class session participants discussed the differences between inquiry and problem solving as a means to construct an initial understanding of inquiry-based learning; setup a one-gallon aquarium with live elodea plants and fish (guppies) to observe over time; and began creating inscriptions (sketches, drawings, concept maps, graphs, tables, experimental ideas, etc., Roth and McGinn, 1998) in a notebook that they maintained throughout the course. Participants individually presented an analysis and critique of a science journal article during the second class session as an introduction to authentic scientific research. During the third class session, participants discussed several chapters from their textbook, *Inquire Within: Implementing Inquiry-Based Science Standards* (Llewellyn, 2002); received either pill bugs or mealworms (self-selected) to conduct inquiry-based investigations with over the duration of the course; and were introduced to the Secondary Teacher Analysis Matrix, STAM (Gallagher & Parker, 1995) as a means to analyze their

teaching practices. The inservice teachers were given a videotape and transcript of three-days of their teaching that were collected prior to their participation in the course (Feb. - March, 2003) by the teaching assistant. They were asked to complete the STAM analysis during the summer portion of the course. All participants were asked to submit reflections throughout the course which documented their perceptions of activities.

The summer semester portion of the course consisted of nine, three-hour sessions during the month of June, 2003 which were held in a science lab at the University of Tennessee. The primary activity during this portion of the course was inquiry-based activities conducted with *C-ferns*^{TM} and *Wisconsin Fast Plants*^{TM} as facilitated by the scientist instructor (obtained from *Carolina Biological Supply* Company). They were not initially told the identity of their organisms and were asked to make experimental observations and develop questions they would like to pursue with the "unknowns". Numerous resources were accessible in the science lab including microscopes, a computer (with the capability of taking pictures from the microscopes), and the basic supplies needed for the survival of each organism. Several class discussions were held to allow participants to share their experimental observations and discuss ideas about experimental procedures such as sampling. Aquarium and pill bug/mealworm experimentation continued during the summer portion and the teachers were given opportunities to share their observations and experimental results with each other. Participants examined their own practices and beliefs about teaching science through discussions with each other, the instructors, and journal entries in response to textbook readings, STAM analysis, and course activities. In addition to their textbook, the participants examined standards documents including state standards, the *NSES*, *Science*

for All Americans, and *Benchmarks for Science Literacy* in preparation for creating inquiry-based lesson plans for their own classrooms.

The fall semester portion of the course consisted of two, three-hour sessions and one professional leave day between August and October, 2003 which were held at the county's Teacher Center. The two, three-hour sessions were used to share developing inquiry-based lesson plans; discuss ways to mentor other teachers to use inquiry-based instruction; discuss issues related to urban schools and diverse learners; and plan for and receive guidance for presentations regarding work with the "unknowns" during the summer portion. During the eight-hour professional leave day, the teachers presented their group work with the "unknown" to the whole class and brought in student artifacts as well as lesson plans that they had used within their classrooms. They also planned an hour-long workshop which was presented at the state science teachers' association conference in November, 2003. Three of the five inservice teachers attended and presented at the conference. This workshop was planned in order to share their lesson plans and student artifacts with other teachers as well as to provide an opportunity for other teachers to experience inquiry-based learning. Two of the five inservice teachers attended the international conference for the Association for the Education of Teachers of Science (AETS) in January, 2004 to share their experiences in the course as part of a presentation.

There are several differences between the emphases of the Project INQUIRE course designed for inservice teachers and the "Do-It" course originally designed for secondary preservice science teachers. The "Do-It" course devotes the majority of class time to working with the "unknowns" and a minority of the time to developing and

presenting lesson plans. Due to the fact that the students who take the "Do-It" course have often not had any experience in the classroom as a teacher, it is not practical to spend more time working on lesson plan development. The Project INQUIRE course divided the time equally among working with the "unknowns" and developing inquiry-based teaching lessons. The inservice teachers participating in the Project INQUIRE course needed more time to examine their beliefs and practices regarding science teaching in order to incorporate more constructivist methods of teaching into their repertoires. They had the appropriate teaching experiences to be able to make connections between their experiences in the course and practices in their classrooms. Although the secondary preservice teachers who participated in the Project INQUIRE course are not part of this study, it is important to mention that they were positively influenced by working alongside practicing teachers (elementary level) and hearing their opinions and ideas regarding classroom practice.

Identification of Cases

The five elementary inservice teachers included in this study were selected from different urban schools. All participants agreed to participate in the research by signing a letter of consent (see Appendix B for consent form). Participants were selected based upon their interest in mentoring other teachers as well as their interest in receiving professional development for science teaching. Teaching experience among the group ranged from 1 - 28 years. The demographics of this group of teachers are described in detail in Chapter IV. All five participants were female. Four were non-Hispanic White and one was African American. Three of the five teachers had previously received Urban Impact's mentor training and were part of their school's mentoring teams. The remaining

two teachers agreed to receive the mentor training at a later date. Three of the five schools represented were *Project Grad* schools. *Project Grad* seeks to assist students in high needs urban schools to prepare for a college education through a consistent program (of academics and classroom management) from Kindergarten through high school.

Question/Instrumentation Alignment

The research questions have been answered using a mixture of qualitative (interviews, observations, journal reflections and questionnaires) and quantitative (questionnaires) measures. All interviews, observations, and questionnaires were collected prior to and at the completion of the Project INQUIRE course. Participant's journal reflections were collected throughout the duration of the course.

Table 3 shows the alignment of research questions and instruments used in this study. Permission to use each instrument was obtained from the instrument author(s) via email correspondence. The following instruments were used in this research study and are included in the appendix if approved by the author(s):

1. Project INQUIRE Interview Protocol - 19 questions (1 question with four parts). Incorporated 20 questions from the Teacher's Pedagogical Philosophy Interview (TPPI) (Richardson & Simmons, 1994) and 2 additional questions to determine participant's understanding of scientific inquiry (see Appendix C.1 for instrument).
2. Secondary Teacher Analysis Matrix (STAM) - Science Version (Gallagher & Parker, 1995) (see Appendix D.2 for instrument).

Table 3. Research Question/Instrumentation Alignment.

Questions: Do teachers who complete Project INQUIRE change:				
	Instructional practices?	Beliefs and attitudes of science instruction?	Understanding of scientific literacy?	Mentoring strategies or efficacy?
Pre and Post Project INQUIRE Data Collection				
Interview questions	X	X	X	
Observations w/STAM[a]	X			
CLES[a]		X	X	
SIDESTEP[a] questions	X			
STEBI[b]		X		
MNSKS[c]			X	
Mentoring Efficacy Questionnaire				X
Collected during the Project INQUIRE course				
Reflective Journal Questions		X	X	X

[a]Salish I Research Project Supplement, (1997) Instruments: STAM - Secondary Teaching Analysis Matrix (Science Version); CLES - Constructivist Learning Environment Survey; SIDESTEP - Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs. [b]STEBI - Science Teaching Efficacy Belief Instrument (Enochs & Riggs, 1990). [c]MNSKS - Modified Nature of Scientific Knowledge Scale (Meichtry, 1992).

3. Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP) - Part II of three parts was used (see Appendix E for instrument).
4. Constructivist Learning Environment Survey (CLES) (Taylor, Fraser, & White, 1994) (see Appendix F.1 for instrument, F.2 for scoring instructions, and F.3 for Participant Calculations).
5. Science Teaching Efficacy Belief Instrument (STEBI) (Enochs & Riggs, 1990) (see Appendix G.1 for instrument and G.2 for Scoring Instructions, and Calculations).
6. Modified Nature of Scientific Knowledge Scale (MNSKS) (Meichtry, 1992). (see Appendix H.1 for scoring instructions and H.2 for Participant Analysis)
7. Mentoring Efficacy Questionnaire (see Appendix I.1 for instrument and I.2 for Scoring instructions and Participant Analysis).

Question one, "Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?" was answered using a combination of instruments. The primary instruments used to answer this question were the STAM through direct observations of participant's teaching and selected interview questions. Supporting data came from the SIDESTEP instrument.

Question two, "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?" was answered using a combination of instruments.

Selected interview questions were the primary source of data. Supporting data came from the CLES and STEBI instruments and participant's reflective journal responses.

Question three, "Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?" was answered using a combination of instruments. Selected interview questions were used to determine changes in participant's understanding of the nature of science and scientific inquiry. The MNSKS, CLES, and reflective journal questions were used as supplementary data.

Question four, "Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?" was answered using the Mentoring Efficacy Questionnaire and reflective journal responses.

Data Analysis

Primary Instruments

Project INQUIRE Interview Protocol

The Project INQUIRE interview was used to address the first three research questions as outlined in Table 4. The TPPI questions were coded into 4 categories within the three research questions. For the purposes of this study, question one was coded as Teacher Actions (TA), Question two as Student Actions (SA) and Teacher's Philosophy of Teaching (PT), and Question three as Teacher and Content (TC). Definitions of the coding terms TA, SA, PT, and TC were provided in Chapter I within the Definition of Key Terms.

Table 4. Project INQUIRE Interview Questions Aligned with Research Questions.

Research Question	Project INQUIRE Interview Questions
#1 Teacher Actions (TA)	4c. What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23)[a] 4d. What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24) 5. How do you decide what to teach and what not to teach? (18) 6. How do you decide when to move form one concept to another? (19) 9. In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33) 14. Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25) 15. How do you accommodate students with special needs in your classroom? (38)
#2 Student Actions (SA) and Teacher's Philosophy of Teaching (PT)	1. How would you describe yourself as a classroom teacher? (1) PT 2. What do you believe are your main strengths as a teacher? (39) PT 3. In what areas would you like to improve as a teacher? (40) PT 4a. Describe the best teaching/learning situation that you have experienced. (21) PT 4b. In what way do you try to model that best teaching/learning situation in your classroom? (22) PT 7. How do you know when your students understand a concept? (30) SA 8. How do you believe students learn best? (29) SA 10. When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) PT 11. What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20) PT 13. What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because ________________". (37) SA
#3 Teacher and Content (TC)	12. What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) TC 16. What is science? (14) TC 17. What are some of the things you value most about science? (28) TC 18. How would you define scientific inquiry?[b] 19. Please describe an experience you have had learning/teaching by inquiry.[b]

[a]# in parentheses corresponds to TPPI question aligned with Super Code Matrix. [b]Non-TPPI interview questions.

All interviews were audio taped and transcribed soon the interview took place. The pre-interviews were approximately 40-50 minutes in length and the post-interviews were approximately 20-30 minutes in length. Participants were asked to review their pre interview responses for each question and indicate changes to any views. Table 5 includes the dates for the pre- and post- interviews for each participant. TPPI responses were analyzed according to an adapted version of the Coding Scheme for the TPPI (see Appendix C.2). The two interview questions (# 18 and 19) that did not originate from the TPPI were analyzed separately for themes. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Table 5. Project INQUIRE Pre and Post Interview Dates.

T#[a]	Name[b]	Pre-Interview	Post-Interview
T1	Marie	3/13/03	2/4/04
T2	Tee Jay	3/19/03	11/7/03
T3	Daphne	3/14/03	11/13/03
T4	Shannon	4/15/03	11/14/03
T5	Laura	3/12/03	11/25/03

[a]T#: Teacher number. [b]Pseudonyms are used.

Levels of TPPI analysis.

I. Level one analysis - Each question has a concept map used for coding responses. One question was analyzed for each participant before moving on to the next question. Text that corresponded to one or more of the categories on the maps was highlighted on the transcripts and the corresponding code number and letter(s) were placed in the margin of the transcript.

II. Level two analysis - One Super Code Matrix (Appendix C.3) was copied for each participant. The code number and letter(s) were copied into the corresponding cell of the super code matrix. Excerpts from each participant's transcripts were used to illustrate participant's views of the study's research questions one - three. Views were categorized according to the level two coding categories of didactic, transitional, conceptual, early constructivist, experienced constructivist, and constructivist inquiry.

III. Level three analysis - The six, level two coding categories were collapsed into three categories. Didactic and transitional were combined to form teacher-centered; conceptual remained conceptual; and early constructivist, experienced constructivist, and constructivist inquiry were combined to form student centered. One paragraph was written to illustrate each research question.

IV. Level four analysis - An additional level of analysis was completed in which a numerical average was calculated for each classroom aspect described in level two analysis as described by Brown (2002). An ordinal number ranging between one and six was assigned to 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. The numerical averages were used to compare each participant's pre and post interview responses (See Appendix C.4 for TPPI Average Calculations by Participant and Question).

A. To determine the TPPI averages for each participant, the coded style responses were averaged for each question (from the Project INQUIRE protocol). If all responses for a particular question were coded as the same style the corresponding number was assigned (i.e., didactic would be assigned 1). If a participant had responses exhibiting more than one style, the corresponding numbers were averaged for each question (i.e., didactic, transitional, and conceptual styles - add 1, 2, and 3, and divide by 3).

B. An average was calculated for each research question (one-three) by averaging the averages for each individual interview question (calculated as described in part A.) within the Teacher Actions (TA), Student Actions (SA), Teacher's Philosophy of Teaching (PT), and Teacher and Content (TC) categories (see Appendix C.4 for calculations for each participant).

C. "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" (Brown, 2002, pg. 79). In addition to the wobble term described by Brown (2002) this study included a wobble between 4 and 5 reported as 4/5. The value signified the participant's wobbling between early constructivist and experienced constructivist.

STAM Analysis

The STAM observation protocol (Gallagher & Parker, 1995) was selected to determine changes in participant's instructional practices (see Appendix D for STAM materials). This instrument is used to classify teaching on a continuum between teacher-centered, didactic instruction and student-centered, constructivist inquiry instruction in five aspects of classroom teaching including content (4 rows), teacher's actions (7 rows), student's actions (5 rows), resources (3 rows), and environment (3 rows) as shown in Figure 5. Table 6 describes each of the teaching styles represented in the STAM matrix.

Each participant was observed and videotaped during three-four days of classroom instruction prior to and at the completion of the Project INQUIRE course as suggested by the STAM's standard operating procedures. Duggan-Haas, Gallagher, & Parker (2004) recommend using three hours of classroom observations when using the STAM instrument. The researcher scheduled an hour observation each day with the participants; however, three of the five teachers did not teach an hour of science daily, particularly during the pre-observation time period. Table 7 lists the pre- and post observation dates and hours of observation for each participant.

A limitation of this analysis is that the researcher did not have a co-researcher that analyzed the participant's teaching styles to introduce inter-rater reliability. However, the

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*
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
ENVIRON.	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	*similar from all students* *few*	*some*	*many*

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.

Figure 5. Secondary Science Teacher Analysis Matrix.

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 & instructional 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 investigations	10	
by T	by T & Ss			
considers in instr. decisions	assessment drives T' s decisions	T is co-investigator w/ self-directed Ss	11	
S's 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 some about understanding	about understanding	about understanding & planning	14	
Ss contribute examples & 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 investigation		

Figure 5. Continued.

Table 6. Description of STAM Teaching Styles.

Teaching Style	Description
A. Didactic Teaching	Probably most closely associated in people's minds with the lecture method. However, this is an oversimplification. What is implied by this category is highly 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. Teachers that fall into this stylistic category commonly say, "My job is to present the information, it is the students' job to learn it."
B. Transitional Teaching	Lies between didactic and conceptual teaching. As a consequence, it shows attributes of both. It may characterize a well-established, stable teaching style or a transformational state between didactic and conceptual teaching. 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 of an engaging, interactive manner. This instructional mode is frequently seen in secondary classrooms as teacher's present information to students and then ask them questions about it or respond to students' questions.
C. Conceptual Teaching	Differs from didactic teaching in each of the dimensions of STAM: 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. Many effective secondary science teachers demonstrate this approach to teaching. On the surface, their classrooms may look quite like those in the previous two modes, but closer examination shows very profound differences.

Table 6. Continued.

Teaching Style	Description
D. Early Constructivist Teaching	Represents a beginning stage in the transformation, which usually initiates from conceptual or transitional teaching to constructivist teaching. In this stage, a shift begins 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 others' emerging understanding and application of science concepts. In addition, writing will be more evident in most constructivist classrooms. Again, this transitional state, like that in "transitional teaching" represented in column 2 of STAM may be a terminal state with teachers "locked" into low level of constructivist teaching. In reality, many examples of constructivist teaching tend to belong in this category due to the fact that constructivist teaching has been widely promoted and has gained in popularity. Early constructivist teaching may be rife with problems of student and information management. In other words, an early constructivist teacher is not necessarily a better teacher than a conceptual teacher is. However, it appears to be an important transition from either "transitional" or "conceptual" teaching as teachers attempt to adopt a constructivist approach to teaching.
E. Experienced Constructivist Teaching	A more polished version of the preceding category. The content of instruction brings out a more 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.

Table 6. Continued.

Teaching Style	Description
F. Constructivist Inquiry Teaching	Characterized by instruction operating in the mode of self-sustaining inquiry. This instructional model is frequently promoted by advocates of project-based learning, but in spite of strong advocacy, self-sustaining inquiry in secondary classrooms is rare. Therefore it is not readily observable in classrooms. 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.

Source: Duggan-Haas, Gallagher, & Parker (2004, p. 9-12). Used with permission of the author.

Table 7. Pre- and Post- Observation Dates and Times for Each Participant.

T#[a]	Name[b]	Pre-Observations	Time - pre; hours:min	Post-Observations	Time - post; hours:min
T1	Marie	3/7, 3/13, 3/21, 2003	3:12	1/7, 1/14, 1/21, 2004	3:05
T2	Tee Jay	3/20-21, 4/1, 2003	2:15	11/5-7, 2003	2:42
T3	Daphne	4/15-17, 2003	2:12	10/8-10, 2003	2:49
T4	Shannon	4/17, 4/24, 4/29, 2003	2:41	11/6-7, 11/10, 2003	2:50
T5	Laura	4/14-17, 2003	3:37	10/7, 10/10, 10/16-17, 2003	3:09

[a]T#: Teacher number. [b]Pseudonyms are used.

researcher participated in data collection and analysis as a co-researcher for a previous doctoral dissertation study in which at least 87% inter-rater reliability was achieved (Brown, 2002). The researcher also attended a workshop on using the STAM conducted by Don Duggan-Haas and Jim Gallagher (2004 AETS International Meeting, Nashville, TN, January 8).

Stages of STAM analysis.

I. After the researcher observed each classroom and collected the videotapes of each teacher, a *Record of Activities* in the form of an activity/transition timeline was created for each teacher (see Appendix D.1 for Standard Operating Procedures and D.3 for STAM Analysis and Video Portfolio Template). The record included a column for the date, the tape number (1, 2, 3), A or T designating activity (content/ instruction) or transition, the beginning time and a description of each activity or transition (see Appendix J for participant's pre- and post- Records of Activities).

II. The *Record of Activities* was used to create a *STAM Analysis Record* (Revised version). Rather than using the matrix shown in Figure 5 as suggested in the Standard Operating Procedures (Appendix D.1), the researcher used a different format shown in Table 8 (approved through personal communication with Jim Gallagher, co-author of original STAM, Jan. 8, 2004). The *Revised STAM Analysis Record* was used to code the teaching style of each activity as didactic with an A, transitional with a B, conceptual with a C, early constructivist with a D, experienced constructivist with an E, and constructivist inquiry with an F (See Appendix K.1 for participant's pre- and post STAM Analysis Records).

Table 8. Revised STAM Analysis Record (Template).

	Day 1	Day 2	Day 3	Summary
	Provide a column/activity	Provide a column/activity	Provide a column/activity	
Content Rows 1-4 Score activities individually and then choose a summary score.				
1 Structure				
2 Use of examples and connections				
3 Limits, exceptions, and multiple interpretations				
4 Processes & history of science				
Teacher's actions and assessment Rows 5-11				
5 Methods				
Label each activity w/method used (i.e. discussion, lecture, review, Q&A, reading, etc.) then provide a summary for 3-day period.				
6 Labs, demonstrations, and hands-on				
Check each activity in which a lab/demo/hands/on is used and then provide a summary for 3-day period				
7 Teacher-Student interactions				
Score activities individually and then choose a summary score.				
8 Teacher Questions				
Place a check in each column where you observed T ?s, score each of these checked activities individually, and then choose a summary score.				
9 Kinds of Assessment				
Check each activity in which assessment is observed and then provide a summary for the 3-day period. (can include informal teacher questioning, journal, rubric, etc.)				
10 Uses of assessment beyond grading				
Determine how activities checked in row 9 are used and then provide a summary for the 3-day period.				
11 Teacher's responses to students' ideas				
Place a check in each column where you observed this category, score checked activities individually and provide a summary score for the 3-day period.				

Table 8. Continued.

	Day 1	Day 2	Day 3	Summary
	Provide a column/activity	Provide a column/activity	Provide a column/activity	
Students' actions Rows 12-16				
12 Writing and other representation of ideas				
Place a check in each column where ss used writing or other rep. of ideas and then determine a summary for the 3-day period.				
13 Students' questions				
Place a check in each column where you observed s ?s, score each of these checked activities individually, and then choose a summary score.				
14 Student-student interactions				
Place a check in each column where you observed s-s interactions, score each of these checked activities individually and then determine a summary for the 3-day period.				
15 Student-initiated activity				
Place a check in each column where you observed student-initiated activity, score each of these checked activities individually, and then provide a summary score for the 3-day period.				
16 Students' understanding of Teacher expectations				
Score activities individually and then provide a summary score for the 3-day period.				
Resources Rows 17-19 provide a summary score for the 3-day period				
17 Richness				
List resources used for each activity				
18 Uses				
19 Access				
Environment Rows 20-22 provide a summary score for the 3-day period.				
20 Locus of decision-making				
Determine the overall feeling for the 3-day period				
21 Teaching aids displayed				
List posters, models, etc.				
22. Students' work displayed				
List posters, models, assignments (on wall, bulletin boards, or T or S designed "books" of work, etc.				

Note: T=Teacher; S=Student; s-s=student to student interaction

Directions for completing the revised form of the STAM Analysis Record include:

A. Watch videotape and read transcript (*Record of Activities*).

B. Make a generalization as to whether the teaching-style is teacher-centered or student-centered. Generally those who are teacher-centered will use A (didactic), B (transitional), or C (conceptual) and student-centered will use D (early constructivist), E (experienced constructivist), or F (constructivist inquiry). It is possible to have a mixture/blend of the styles.

C. Highlight teacher and student questions within transcript (use different colors for student and teacher questions).

D. Make note of student-student interactions and instances in which students volunteer examples that are related (and unrelated) to the topic on the transcript.

E. Use the suggestions for each row described in the template (Table 8) to help complete the record one row at a time.

F. Provide a *Summary STAM score* for each row for the 3-Day observation period.

G. Set the record aside for a couple of hours/days and then review responses to see if there is agreement with original assessment.

III. Use the *STAM Analysis Record* completed in part II. to create a *Summary of the Video Portfolio* (see Appendix D.1 and D.3).

A. The summary consists of seven paragraphs labeled overview, content, teacher's actions, student's actions, resources, environment, and other.

B. Based upon the summary STAM scores, the corresponding rows within each category of the STAM Record (Appendix K.1) and the STAM Analysis Matrix (Appendix D.2) are used to write each sentence of the paragraph.

C. Within the overview paragraph, values enclosed in parentheses indicate the frequency each category of teaching (i.e., didactic, transitional, or conceptual), was observed (Brown, 2002).

IV. The summary STAM score for the twenty-two subcategories (rows) was compiled in a tabular format within each case study for ease in comparison of participant's pre and post scores.

V. A STAM numerical average was determined for the five categories of the matrix and the total STAM instrument (see Appendix K.2 for STAM Average Calculations by participant). The following procedure (A-G) was used as described by Brown (2002, p. 74-75).

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 sub categorical items (1-4) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 4.

C. To determine the STAM teacher's actions average for each participant, the coded sub categorical items (5-11) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 7.

D. To determine the STAM student's actions average for each participant, the coded sub categorical 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 sub categorical items (17-19) 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 sub categorical items (20-22) were assigned the correct corresponding ordinal number. Those items were then summed and divided by 3.

G. 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.

H. In addition to the "wobble" terms described in step G by Brown (2002) this study also included a wobble between 4 and 5 reported as 4/5. The value 4/5 signified the participant's wobbling between early constructivist and experienced constructivist.

I. Each participant's total STAM summary was calculated by finding the average of the scores on the 22 teaching aspects of the STAM instrument (see Appendix K.2 for calculations).

J. The pre- and post- STAM content (C), teacher's actions (TA), student's actions (SA), resources (R), and environment (E) averages were displayed on a bar graph for each participant (see Appendix K for summary and average calculations). Definitions of the coding terms C, TA, and SA were provided in Chapter I within the Definition of Key Terms.

Supplementary Instruments

SIDESTEP Description and Analysis

The Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP), Part II was used primarily to gather basic demographic information regarding each participant (see Appendix E for instrument, #1-17 out of 18 questions were used). In addition, the SIDESTEP provided information for research question number one regarding each teacher's instructional practices before and after participation in the Project INQUIRE course. The responses provided by the teachers were used by the researcher to supplement the information gathered by classroom observations and interviews.

CLES Description and Analysis

The Salish I Research Project's Constructivist Learning Environment Survey (CLES) Science Teacher Form was used to gather supplementary data for research question number two and three (see Appendix F.1 for CLES survey and F.2 for scoring

guidelines). The CLES contains 42 items with seven items in each of six scales. The response alternatives for each item are in a Likert-style format including almost always, often, sometimes, seldom, and almost never. Four of the six scales incorporate both positively- and negatively-worded item statements. The remaining two scales have only positively-worded item statements.

The CLES is an instrument that is used to evaluate and monitor teaching environments, *as perceived by teachers*, using scales that measure constructivist approaches. Each scale is described in detail within the scoring guidelines for the instrument (see Appendix F). Scale one is the Personal Relevance Scale (PR) and is used to determine the relevance of science instruction to students as perceived by the teacher. This scale measures the capability of the teacher to use the background and everyday experiences of students to guide instruction. Scale two is the Scientific Uncertainty Scale (SU) which

> assesses the extent to which opportunities are provided for students to experience scientific knowledge as arising from theory-dependent inquiry involving human experience and values, and as evolving, non-foundational, and culturally and socially determined (Taylor, Fraser, and Fisher, 1997 p. 296).

Scale three is the Critical Voice Scale (CV) which

> examines the extent to which a social climate has been established in which students feel that it is legitimate and beneficial to question the teacher's pedagogical plans and methods, and to express concerns about impediments to their learning (Taylor, et al., 1997 p. 296).

Scale four is the Shared Control Scale (SC) which is

> concerned with students being invited to share with the teacher control of the learning environment, including the articulation of learning goals, the design and management of learning activities, and the determination and application of assessment criteria (Taylor, et al., 1997, p. 296).

Scale five is the Student Negotiation Scale (SN) which

> assesses the extent to which opportunities exist for students to explain and justify to other students their newly developing ideas, to listen attentively and reflect on the viability of other students' ideas and, subsequently, to reflect self-critically on the viability of their own ideas (Taylor, et al., 1997, p. 296).

Scale six is the Attitude Scale (AT) which measures how students perceive the activities completed in class including how they impact their enjoyment and understanding of science concepts.

Five of the six scales (PR, CV, SC, SN, and AT) were used to provide insights into changes in each teacher's beliefs, and attitudes toward science instruction after participation in the Project INQUIRE course (for research questions one and two). Scale two, the Scientific Uncertainty Scale (SU) was used to provide insights into changes in perceptions regarding the nature of science for research question three.

The CLES scores for each scale were calculated according to the scoring guidelines for each participant before and after course participation (see Appendix F.3 for CLES Scores: Participant Calculations). The scores for all six scales were graphed for

individual teachers for ease in within-case analysis. A graph was created for each scale with all five participants for cross-case analysis. The range of scores for each subscale is 7 to 35 points. For the purposes of this study, a ranking scheme was developed to categorize each teacher's agreement with the subscales. A score of 7-13 indicated a low agreement; a score of 14-20 indicated a low intermediate agreement; a score of 21-27 indicated a high intermediate agreement; and a score of 28-35 indicated a high agreement.

STEBI Description and Analysis

The Science Teaching Efficacy Belief Instrument (STEBI) - Form A, designed for elementary inservice teachers, was used as a supplementary source for research question two regarding each participant's attitudes and beliefs toward science instruction (see Appendix G.1 for instrument and G.2 for scoring instructions). The STEBI contains 13 positively-written item statements and 12 negatively-written item statements divided among two scales. The response alternatives for each item are in a Likert-style format including strongly agree, agree, uncertain, disagree, and strongly disagree. The two scales include the Personal Science Teaching Efficacy Belief Scale (self-efficacy dimension) and Science Teaching Outcome Expectancy Scale (outcome expectancy dimension). Personal teaching efficacy is the "belief in one's capabilities to organize and execute the courses of action required to produce given attainments, whereas outcome expectancy is a judgment of the likely consequence such performances will produce" (Bandura, 1997, p.3).

Knowledge of self-efficacy beliefs can have the ability to predict behavior (Bandura, 1997). Teachers who have a high sense of self-efficacy are more likely to use student-centered, constructivist teaching practices as compared to teachers who have a low sense of self-efficacy (Czerniak, 1990). They feel they have the ability to implement strategies that can meet students' needs. The outcome expectancy dimension, also known as General Teaching Efficacy, extends to the view of capabilities of teachers in general. Teachers with a low outcome expectancy belief may feel that a students' home environment prevents them from making an impact on student motivation and performance (Bandura, 1997). Therefore, teaching-efficacy beliefs are dependent on the teaching context.

The STEBI scores for each scale were calculated according to the scoring guidelines for each participant before and after course participation (see Appendix G.2 for calculations). A graph was created for each scale with all five participants for cross-case analysis. The range of scores for the Personal Science Teaching Efficacy (PE) scale is 13 to 65 points. For the purposes of this study the range of scores was divided into categories: a score of 13-30 points was labeled low PE; a score of 31-48 points was labeled average PE; and a score of 49-65 points was labeled high PE. The range of scores for the Outcome Expectancy (OE) scale is 12 to 60 points. The OE scores were divided into categories as well, including: 12-28 points as low OE; 29-44 points as average OE, and 45-60 points as high OE.

MNSKS Description and Analysis

The Modified Nature of Scientific Knowledge Scale, MNSKS, (Meichtry, 1992) was used as a supplementary source for research question three regarding changes in participant's understandings of scientific literacy, in particular nature of science issues (see Appendix H.1 for scoring instructions). The MNSKS contains 32 positively and negatively written item statements with eight statements in each of four subscales. The response alternatives for each item are in a Likert-style format including strongly agree, agree, neutral, disagree, and strongly disagree.

The four subscales of the instrument reflect different aspects of the nature of science. These subscales measure participant's understandings of the creative, developmental, testable, and unified nature of science. The creative subscale reflects that "scientific knowledge is partially a product of human creativity", the developmental subscale reflects that "scientific knowledge is tentative", the testable subscale reflects that "scientific knowledge is capable of empirical test", and the unified subscale reflects that "the specialized sciences contribute to an interrelated network of laws, theories, and concepts" (Meichtry, 1992, p. 391).

The MNSKS scores for each subscale were calculated according to the scoring guidelines for each participant before and after course participation (see Appendix H.2 for Participant Analysis). The scores for all four subscales were graphed for individual teachers for ease in within-case analysis. Graphs were created for each scale with all five participants for ease in cross-case analysis. The range of scores for each subscale is 8 to 40 points. For each subscale, a score of 24 points indicates a neutral position while a

score between 25 and 40 is within the accepted view of the nature of science, and a score between 8 and 23 is within the unaccepted view. The overall score for all four subscales ranges from 32 to 160 points. A score of 96 on the overall scale score is considered neutral while scores between 97 and 160 are within the accepted view of the nature of science, and scores between 32 and 95 are within the unaccepted view.

Mentoring Efficacy Questionnaire Description and Analysis

The Mentoring Efficacy Questionnaire was used to determine participant's perceived efficacy toward mentoring their colleagues. The instrument was developed by Urban IMPACT as a pre-assessment to be given to teachers during initial mentor training. The questionnaire was adapted for use in the Project INQUIRE course to emphasize aspects important to science instruction and science-specific mentoring (see Appendix I, for instrument).

The questionnaire contains 20 positively-written item statements. Response alternatives for each item are in a Likert-style format including strongly agree, agree, uncertain, disagree, and strongly disagree. The scores for this portion of the instrument can range from 20 to 100. For the purposes of this study the range of scores was divided into categories: 20-40 points indicated a low mentoring efficacy; 41-60 points indicated a low intermediate mentoring efficacy; 61-80 points indicated a high intermediate mentoring efficacy; and 81-100 points indicated a high mentoring efficacy belief. Two open-ended questions were also included that asked participants to describe their greatest strengths and challenges as a (potential) science mentor.

The scores were calculated for each participant before and after course participation (see Appendix I.2 for Participant Analysis). The scores for the Likert-items and the two open-ended questions were analyzed for each case. A special focus was given to question number 20 of the Likert-items regarding helping a protégé implement inquiry-based instruction. A graph was created incorporating all five participant's results to the Likert-portion of the questionnaire for ease in cross-case analysis.

Reflective Journal Responses

The teachers were required to keep reflective journals throughout the duration of the Project INQUIRE course. They were given a list of questions to choose from in order to guide their reflections. Questions included how do you feel about the course?; what frustrations, if any, are you experiencing?; how much do you understand about what you are supposed to be doing?; is this course similar/dissimilar to previous science courses/experiences?; what is the nature of scientific thinking and specifically yours?; how is your own scientific thinking developing?; what is scientific thinking?; what is the nature of science?; how would you use the information that you are learning to mentor novice (or experienced) teachers to use the inquiry process as a part of their teaching?; and how would you apply what you are learning in your own classroom? Participants were not required to answer any specific number of these questions; however, they were expected to use them as a guide for developing their journals.

Participant's journal entries were used as a supplementary source for research questions two (changes in beliefs and attitudes toward science instruction), three (changes in understanding of scientific literacy) and four (changes in perceived efficacy toward

mentoring). Participant's responses were analyzed for themes applicable to each research question.

Definition of Notable Changes

In order to more easily interpret the results of the various instruments, it is desirable to categorize the changes from pre to post as being relatively small, or more notable. The sample size in this study is small, so it is not practical to produce descriptive statistics to determine these categories. While it is necessary to view the categories as qualitative and descriptive in nature, it is also desirable to justify the categories as reasonable.

When determining how to categorize changes there are several factors that are common to any instrument that produces a numerical score. First, the range of possible values should be significantly larger than the standard deviation of the results. If the range is less than two standard deviations, then, assuming the scores are normally distributed, at least 32% of the results would be at the extreme ends of the range of possible scores. This would mean that a large portion of the potential information that could have been gained would be lost. This would be analogous to a photograph that is an extreme close-up (Moore, 2004)

Second, if the range is very large, compared to the standard deviation, then most observed scores will fall into a narrow range of values, and most of the possible scores will never be used. If the range is greater than eight standard deviations, then, assuming the scores are normally distributed and the mean score is in the middle of the range of possible values, the outer two standard deviations of the range would be used less than

0.3% of the time. This is wasteful, gives a false impression of the resolution of the instrument, and would be analogous to an extremely wide-angle photograph where the subject only takes up a small portion of the picture (Moore, 2004).

Due to these factors, it seems reasonable to assume that most well designed instruments will possess a range of values that is somewhere in the range of four to six standard deviations. This is a factor that is often seen when dividing scores into categories (e.g. A, B, C, D, U grading scale). Finally, for the purposes of this paper, changes that are larger than one half of a standard deviation will be considered to be notable, while smaller changes will be considered negligible.

The CLES instrument subscales have possible scores ranging from 7 to 35. This range is broken into four categories (7-13 low agreement; 14-20 low intermediate agreement; 21-27 high intermediate agreement; and 28-35 high agreement). Each category has a range of seven (with the exception of the high agreement category, with a range of eight). If we assume that the size of these categories is similar to the size of one standard deviation, then a change of four points, pre to post, would be more than one half of one standard deviation. In this paper, changes of four or more points on the CLES instrument subscales will be considered notable.

The STEBI has been used in larger studies (Enochs & Riggs, 1990) and the resulting standard deviations were in the range of 5.6 to 7.7. Here again, a change of four or more points, pre to post, would be more than one half of one standard deviation. In this paper, changes of four or more points on the STEBI instrument will be considered notable.

The MNSKS subscales have possible scores ranging from 8 to 40. This range is broken into three categories (8-23 "unaccepted", 24 "neutral", and 25-40 "accepted"). Assuming, as we did with the CLES instrument, that the ranges are on the order of four standard deviations in size, then a change of 4 points, pre to post, would represent one half of one standard deviation. In this paper, changes of four or more points on the individual MNSKS subscales will be considered notable. The total MNSKS score is the sum of the four different MNSKS subscales with a total range of 32 to 160. Thus, a change of 16 points, pre to post, on the total MNSKS score will be considered notable.

The Mentoring Efficacy Questionnaire (MEQ) has possible scores ranging from 20-100. This range is broken into four categories (20-40 low agreement; 41-60 low intermediate agreement; 61-80 high intermediate agreement; and 81-100 high agreement). Each category has a range of twenty. If we assume that the size of these categories is similar to the size of one standard deviation, then a change of ten points, pre to post, would be one half of one standard deviation. In this paper, changes of ten or more points on the MEQ instrument will be considered notable.

Summary

The collective case study methodology has been described in which data analysis is thick in description and elicits themes and assertions. The background and description of the PI course were included. The five individual cases were briefly introduced. A detailed description was provided for the selection of instruments to align with the research questions. This chapter detailed the method and procedures used to analyze each instrument included in the study and the results are presented in the following chapter.

CHAPTER IV: RESULTS

Organization of the Chapter

The Chapter is organized into three sections:

1. Presentation of within-case analysis for each teacher participant arranged by the four research questions.
2. Presentation of cross-case analysis of the five teacher participants arranged by the four research questions and a fifth section that presents themes developed from interview questions and reflective journal responses.
3. Summary of key findings of the five case studies.

Within-Case Analyses

Introduction

Each case was divided into six sections using the following outline for each teacher. The outline references the sections of Chapter III and/or the appendix that can be referred to for descriptions of the methods used.

I. Basic Demographic Information - Source SIDESTEP instrument questions 1, 2, 6-10, and 13-15 (see Appendix E for instrument)

II. Research Question one analysis - "Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

A. STAM Analysis (see Appendix D, J, and K) - Chapter 3 - Stages of STAM analysis describes method
   a. STAM Video Portfolio - pre and post
   b. Summary STAM score - pre and post, table format (see Appendix K.1 for Analysis summary by participant)
   c. Numerical averages for the five categories of the STAM matrix - pre and post, graph format (see Appendix K.2 for calculations)

B. Interview Analysis - analysis of 7 questions listed in Table 4. Procedure - Chapter 3, Levels of TPPI Analysis

a. Table of excerpts from interview transcripts for three aspects of Teacher Actions in the classroom including Teacher Actions (TA), Context (C), and Teacher's Response to Student Diversity (SD) - pre and post
b. Paragraph description of TA, C, and SD excerpts illustrating aspects of the Teacher Action style. Numerical average of TA (TA, C, and SD combined) within paragraph. Calculations - Appendix C.4

C. SIDESTEP Analysis of questions 3-5, 11, and 16-17 including a paragraph for each question (see Appendix E for instrument)
D. Summary of Participant Results for Research Question One

III. Research Question two analysis - "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

A. Interview Analysis - analysis of 10 questions listed in Table 4. Procedure - Chapter 3, Levels of TPPI analysis
    a. Table of excerpts from interview transcripts for two aspects of classroom: Student Actions (SA) and Teacher's Philosophy of Teaching (PT) - pre and post
    b. One paragraph each for SA and PT, illustrating aspects of teacher's beliefs and attitudes. Numerical average of SA and PT included within respective paragraph. Calculations - Appendix C.4
B. CLES analysis (see Appendix F.1 for instrument, F.2 for scoring instructions, and F.3 for calculations)
    a. Graph of Personal Relevance (PR), Critical Voice (CV), Shared Control (SC), Student Negotiation (SN), and Attitude Scale (AT) - pre and post
    b. Paragraph description for subscales (PR, CV, SC, SN, and AT)
C. STEBI analysis (see Appendix G.1 for instrument and G.2 for scoring instructions and calculations) - Paragraph description for each participant's pre and post self-efficacy and outcome expectancy scores.
D. Reflective Journal Questions - Description of themes developed from applicable journal responses (see Chapter 3 for list of questions)
E. Summary of Participant Results for Research Question Two

IV. Research Question three analysis - "Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

A. Interview analysis - analysis of 5 questions listed in Table 4. Questions 12, 16, and 17 analyzed with TPPI procedure (Chapter 3 - Levels of TPPI analysis). Questions 18 & 19 analyzed through thematic analysis (see Chapter 3 - Project INQUIRE Interview Protocol for procedure).
    a. Table of excerpts from interview transcripts for Teacher and Content (TC) aspect of classroom - pre and post

b. Three paragraph summary - one for TC, one for participant's definition of inquiry (question 18), and one for participant's experience teaching or learning by inquiry (question 19).
c. Numerical average of TC - pre and post, averages are included in the paragraph described in A.b. for TC (Calculations - Appendix C.4)

B. MNSKS Analysis (see Appendix H.1 for scoring instructions and H.2 for calculations)
   a. Graph of four subscales of instrument - pre and post
   b. Description of subscale results and a description of the overall score for pre and post
C. CLES Analysis (see Appendix F.1 for instrument, F.2 for scoring instructions, and F.3 for calculations) - One paragraph description for the Scientific Uncertainty (SU) subscale pre- and post-scores
D. Reflective Journal Questions - Description of themes developed from applicable journal responses (see Chapter 3 for list of questions)
E. Summary of Participant Results for Research Question Three

V. Research Question four analysis - "Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

A. Mentoring Efficacy Questionnaire Analysis, MEQ (see Appendix I.1 for instrument and I.2 for calculations)
   a. One paragraph describing participant's score - pre and post and pre- and post-response to question statement 20 (Statement: I feel confident helping a protégé implement inquiry-based science instruction.)
   b. One paragraph describing participant's perceived strengths and challenges of being a science mentor.
B. Reflective Journal Questions - Description of themes developed from applicable journal responses (see Chapter 3 for list of questions)
C. Summary of Participant Results for Research Question Four

VI. Participant Summary

Notes:

- The following codes are used consistently for TPPI and STAM Analysis - A (1)= Didactic; B (2)= Transitional; C (3)= Conceptual; D (4)= Early Constructivist; E (5)= Experience Constructivist; and F (6)= Constructivist Inquiry. No participant scored within the Constructivist Inquiry range for any category. The styles were coded with numbers for the purpose of calculating a numerical average.

- Notable changes in participant's views as described in Chapter III were: four or more points on the subscales of the CLES, STEBI, and MNSKS instruments; 16 or more points on the MNSKS total scale; and 10 points on the MEQ.

Case Study T1 - Marie

I. Basic Demographic Information

Marie, an African American female, was an experienced teacher in her 28^{th} year of teaching during the 2002-2003 school year. She taught earth, physical, and life science in a science lab at an inner-city, elementary magnet school which was also a *Project Grad* school. She taught all Kindergarten through 2^{nd} grade students within the school who visit the science lab for an hour, once a week. Observations were completed within 2^{nd} grade classes. Marie indicated her non-teaching assignments as an athletic coach, faculty committee member, class sponsor, club sponsor (non-mathematics or science), study hall supervisor, and homeroom supervisor. She indicated spending 20 hours per week preparing for science prior to and at the completion of the Project INQUIRE (PI) course. She suffered a personal illness after the summer portion of the course, took a leave of absence from school, and was not able to complete the fall semester portion with the rest of the class. Post-observations and assessments were collected for Marie in January after she had recuperated from her illness.

Marie had attended a state, regional, or national science teacher conference four or more times within the past year, prior to participation in the PI course. She also had made two presentations at local teacher conferences and/or inservice programs. She was a member of the National Science Teachers' Association (NSTA). She had received Urban IMPACT's mentor training and was a member of her school's mentor core team.

The demographics of the two classes that were observed for the pre- and post-observations are described in Table 9. She had a total of 16 students in the pre observations and 14 students in the post observations. Marie's school serves

Table 9. Marie's Class Demographics Pre- and Post- Observations.

	Males		Females	
	Pre	Post	Pre	Post
African American	7	4	4	5
White	3	2	2	3
Totals	10	6	6	8

Kindergarten-5th grade students, of which 86.5% are economically disadvantaged. The demographics of the student body are 12.6% White, 85.1% African American, 2.0% Hispanic, and 0.2% Asian.

II. Research Question One Analysis

> "Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

STAM analysis.

Marie's STAM Video Portfolio for pre and post observations can be found in Figure 6. The Video Portfolio provides an overview of the participant's instruction as well as a description of the teaching style observed for each of the 22 teaching aspects of the STAM. Marie's summary STAM scores for pre and post observations are located in Table 10 and her numerical averages for the five categories of the STAM matrix are located in Figure 7 (see Appendix K.1 for summary STAM scores and K.2 for average calculations). Chapter III, Stages of STAM analysis describes the method (see Appendix D.1 for Standard Operating Procedures, D.2 for Analysis Matrix, D.3 for Video Portfolio template, and Appendix J for Pre and Post STAM Records of Activities for each participant).

STAM Pre-Observations
OVERVIEW: The focus of these lessons was physical science - matter. Each class period began with a review of the previous week's activities, followed by an introduction to matter on day one, or a practice of matter identification on day two and three. Daily, the students were divided into two groups and one group worked on a computer program while the other group completed a hands-on activity (making gloop, play-dough, and silly putty) with the teacher (groups switched after 20 minutes). Class ended daily with a closure led by the teacher. Didactic - 6.5; Transitional - 6.5; Conceptual - 8; Early Constructivist - 1[a]
CONTENT: 1A, 1B[b]. Structure of content is primarily factoids with some descriptive activities in which concepts and factoids are given equal emphasis. 2C. Examples and connections made by teacher to real world events, related ideas, and key ideas of matter. 3B, 3C. Limits, exceptions, and alternate interpretations are primarily presented as part of the content; however, at times these limits are not integrated with other content. 4A, 4C. During class discussions, there is no explicit mention of "how we know"; scientific method is presented as rote procedure. During daily hands-on activities, "how we know" is included in content; teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5C. Rich repertoire of teacher-centered teaching methods, including hands-on. 6B. Some demonstrations and hands-on activities which are overly directed (cookbook). 7C. Teacher-student interaction about correctness of students' knowledge of conceptual content. 8A, 8B. Teacher's questions call for factual recall or are directed toward scientific ideas, not toward connections or applications. They do not build on students' responses. 9C. Assessment includes frequent checking, in addition to tests & quizzes, of students' knowledge. 10B. Assessment is used for checking students' knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12A. Writing and other representations of ideas not used. Short answers predominate. 13A, 13B. Primarily there are few student questions; however, there are a few instances which student questions clarifying procedures dominate. Some questions ask for clarification of terminology or repeat of information. 14A, 14B. Student-student interaction is rare. In situations in which interaction occurs it is mostly about procedure. 15A. Students rarely volunteer examples or analysis. 16C. Students accept procedure and role.
RESOURCES: 17C, 17 D. Multiple resources including a guest teacher (w/guitar), teacher-made manipulatives, audiotape, lab materials, and computers. 18C, 18D. Resources are related to content and illustrate ideas. Some are used to aid understanding and application of ideas. 19B. Access to resources controlled by teacher.
ENVIRONMENT: 20A. Decision-making is teacher-dominated. 21B. Some teaching aids displayed buy may not be related to content. 22A. Few examples of students' work displayed.
OTHER: Students are seated at either a blue table or a green table in the instructional area of the classroom and are addressed as the green or blue group.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 6. Summary of Video Portfolio - Marie (T1).

STAM Post-Observations
OVERVIEW: The focus of these lessons was working with *Wisconsin Fast Plants* ™. On day one the teacher reviewed plants with students; the teacher read a story about *Fast Plants*; and one group of students planted seeds while a second group worked on a computer program about plants. On day two and day three the teacher introduced terminology and plant processes (parts, reproduction, photosynthesis, etc.). The students took turns observing and collecting data on their plants in cooperative groups and working on the computers. Didactic - 1; Transitional - 3.5; Conceptual - 16.5; Early Constructivist - 1[a]
CONTENT: 1B, 1C[b]. Structure of content is partially descriptive with concepts and factoids given equal emphasis and partially explanatory with conceptual content organized around key ideas. 2C. Examples and connections made by teacher to real world events, related ideas, and key ideas of plants. 3C. Limits, exceptions, and alternate interpretations are presented as part of the content. 4C. "How we know" included in content. Teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5C. Rich repertoire of teacher-centered methods, including hands-on. 6B. Some demonstrations and hands-on activities which are overly directed. 7C. Teacher-student interaction about correctness of students' knowledge of conceptual content. 8B, 8C. Teacher's questions are primarily directed toward knowledge of scientific concepts and their connections. They do not build on students' responses. In some cases questions are directed toward scientific ideas, not toward connections or applications. 9C. Assessment is used for frequent checking, in addition to tests & quizzes, of students' knowledge. 10B. Assessment is used for checking students' knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12C. Several forms of writing and other representations of ideas are used. Most are reconfigurations of information provided. 13B, 13C. Student questions clarifying procedures dominate. Some questions ask for clarification of terminology or meaning or repetition of information. 14C. Some student-student interaction about procedure and some about articulating scientific ideas correctly. 15C. Students volunteer some examples related to class activities. 16C. Students accept procedure and role.
RESOURCES: 17C. Multiple resources including Fast Plant materials, overhead transparencies, and computer program are used. 18D. Some resources are used to aid understanding and application of ideas. 19C. Access to resources controlled by teacher, but there is some discussion of access with students.
ENVIRONMENT: 20C. Teacher-controlled. Some sharing of decision-making with students about use of time. 21C. Many teaching aids displayed related to content. 22A. Few examples of students' work displayed.
OTHER: Students are seated at either a blue table or a green table in the instructional area of the classroom and are addressed as the green or blue group.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 6. Continued.

Table 10. STAM Summary Scores - Marie (T1).

	1A Didactic	2B Transitional	3C Conceptual	4D Early Constructivist	5E Experienced Constructivist
Content - C; Rows 1-4 Summary: Pre= 2/3[a] Post= 2/3					
1	■	■●	●		
2			■●		
3		■	■●		
4	■		■●		
Teacher's Actions - TA; Rows 5-11 Summary: Pre= 2/3 Post= 2/3					
5			■●		
6		■●			
7			■●		
8	■	■●	●		
9			■●		
10		■●			
11			■●		
Student's Actions - SA; Rows 12-16 Summary: Pre=1/2 Post= 2/3					
12	■		●		
13	■	■●	●		
14	■	■	●		
15	■		●		
16			■●		
Resources - R; Rows 17-19 Summary: Pre=3 Post=3/4					
17			■●	■	
18			■	■●	
19		■	●		
Environment - E; Rows 20-22 Summary: Pre=1/2 Post=2/3					
20	■		●		
21		■	●		
22	■●				
Total STAM Summary: ■ Pre-Observations =2.2 ● Post-Observations = 2.8					

Notes: Summary values written with a slash indicate score wobbles within range. Teaching styles (A-E) were coded with numbers (1-5) for the purpose of calculating a numerical average displayed in Figure 7.

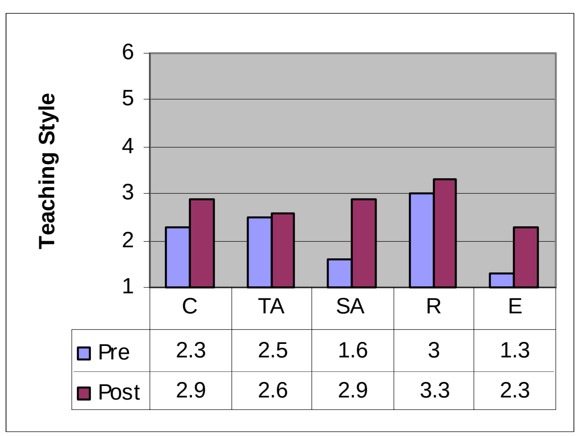


Figure 7. Marie's Summary STAM Scores.

Interview analysis.

Interview analysis for Research Question one includes the analysis of the seven questions listed in Table 4 for Teacher Actions. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher Actions can be located in Appendix C.4.

Marie expressed primarily a teacher-centered Teacher Action (TA) style prior to the Project Inquire (PI) class and a student-centered style after the class. Before the class, she felt it was important to use the state curriculum guidelines to create hands-on lessons to make it fun for the students. She credited the PI course with helping her learn how to incorporate inquiry-based learning with hands-on lessons as a method to motivate students. Marie's response to student diversity was conceptual in that she felt that the peer tutoring inherent to inquiry-based learning is helpful for the special needs child. She evaluated students to determine if they had accomplished goals in order to decide when to move from concept to concept. Marie's pre-average for Teacher Action style wobbled between transitional and conceptual at 2.5; however, her post-average was early constructivist at 4.0. Teacher Action excerpts are located in Table 11.

SIDESTEP analysis.

Marie stated that she used hands-on science and computers to address gender equity issues and the needs of students with "special needs." She did not use a science textbook within the science lab. She used group work, worksheets, discussion, projects, portfolios, lab write-ups, and computers to assess students' understanding. Her top three goals for students' learning in science included: interesting hands-on activities; guided or

Table 11. TPPI Interview Codes and Transcript Statements for Marie (T1) Pre and Post - Question One.

Style	Three categories of Teacher Actions		
	Teacher Actions (# 18[a], 19, 23[b], 24[b], 33)	Context (# 25)	Teacher's Response to Student Diversity (# 38)
A		Pre: "I try to go along with the state curriculum guidelines."(25)	
B	Pre: "The hands-on lessons that we do and trying to make it fun (maximize student understanding)." (33)		
C			Pre: "We have a teaching assistant and we have special computer programs. Like if I put a group on the computer and then if another group is working with me, then I or the assistant can sort of work along, one on one with children who need it."(38) *Post: "With inquiry-based learning, if you have one child that may not feel that he can manage or be able to understand then you have another child that is capable of helping. Peer tutoring and learning is great with the inquiry-based learning especially with the special needs child."(38)*
D	*Post: "With inquiry-based learning you can creatively motivate them to open up their minds, without giving them the actual answer to the question. You let them see the process themselves and they creatively motivate themselves with their peers and through their writing, asking each other questions, and it's really cooperatively learning with their peers that helps them motivate each other." (33)*	*Post: "Working outside the classroom and helping myself to grow this summer while taking the biology class I learned about inquiry-based learning. I learned to motivate my children, not just by hands-on but another way of learning to get them motivated. With inquiry-based learning I can incorporate the hands-on and the curriculum. So by educating myself, I helped my students to learn in a different way."(25)*	
E	Pre: "I move to the next concept when the child has accomplished the goal I have set for him; through evaluation		

Table 11. Continued.

Style	Three categories of Teacher Actions		
	Teacher Actions (# 18[a], 19, 23[b], 24[b], 33)	Context (# 25)	Teacher's Response to Student Diversity (# 38)
	of what the kids are learning." (19)		

[a]Did not answer the question; [b]Questions did not apply.

unguided projects; and personal attention. Marie's pre and post SIDESTEP responses did not vary.

Summary of Marie's results for research question one.

STAM analysis revealed that Marie exhibited behaviors equally across didactic, transitional, and conceptual teaching styles during pre-observations with a total summary average of 2.2. During post-observations, she primarily exhibited a conceptual teaching style with a total summary average of 2.8. Her pre and post summary STAM averages wobbled between transitional and conceptual for classroom aspects of Content and Teacher Actions; increased from an average between didactic and transitional to an average between transitional and conceptual for Student Actions and Environment; and increased from a conceptual average to an average between conceptual and early constructivist for Resources.

Analysis of Marie's TPPI interview questions (beliefs) revealed that her pre-average for Teacher Actions (TA), which wobbled between transitional and conceptual, correlated with her pre-average for STAM TA (behavior). However, her post-TPPI average for TA increased to an average of that of an early constructivist style, while her behaviors remained between the transitional and conceptual levels as revealed by her post-STAM TA average of 2.6.

III. Research Question Two Analysis

"Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

Interview analysis.

Interview analysis for Research Question two includes the analysis of the ten questions listed in Table 4 for Student Actions and Teacher's Philosophy of Teaching. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Student Actions and Teacher's Philosophy of Teaching can be located in Appendix C.4.

Marie expressed primarily conceptual to student-centered statements for Student Actions (SA) prior to and at the completion of her participation in the PI course. She felt that students learned best through hands-on experiences, although she realized that they had a variety of learning styles. She knew students understood concepts by asking them questions during instruction and giving quizzes. After PI participation she added the use of cooperative groups and inquiry-based learning as tools. "Inquiry-based learning is an evaluation tool in and of itself." She felt that students valued their experiences in her class because they liked the excitement of hands-on activities and working together cooperatively. Marie's pre- and post-average for student actions wobbled between conceptual and early constructivist with an average of 3.2 and 3.4 respectively. SA excerpts for Marie are located in Table 12.

Marie's Philosophy of Teaching (PT) was primarily conceptual to student-centered prior to and at the completion of the PI course. She described herself as a

Table 12. TPPI Interview Codes and Transcript Statements for Marie (T1) Pre and Post - Question Two.

Style	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
A	Pre: "I use Learn Star (computer program) and do little quizzes at the end to find out if they actually understand it." (30)		Pre: "A good learner is one that is motivated and one that is actually with the teacher." (13)	
B				
C	Pre: "I think they learn best by hands-on." (29) Pre: "I know they understand through asking (them) questions." (30)		Pre: "I would describe myself as a model, mentor, or motivator because I sort of try to model the way I would like my students to be in the classroom." (1) Pre: "What they are learning here they can take outside the classroom and maybe see how it's working with reading, spelling, English, you know, putting it all together and see how it fits like a puzzle piece." (20) Pre: "Some students share what they are learning with their parents." (20) Pre: "There are so many children, different teaching styles of children. And I've tried to model to be that example for them." (22) *Post: "Some students like to have instantaneous feedback. Just let them know that you don't always have it right then but you can get the answer for them." (22)*	

Table 12. Continued.

Style	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
D	Pre: "Students learning styles are different and through working with them over years of time you can actually pick up what that child's needs are." (29) *Post: "Also, the inquiry-based learning method is an excellent tool for children. They can work in cooperative groups to learn from one another creatively and come up with answers from working in groups with one another and bring back their resources of whatever they've learned to other groups." (29)* *Post: "The inquiry-based learning is an evaluation tool in and of itself because the children evaluate one another through the journaling process, through measuring and through feedback from one another." (30)*	Pre: "They like it because it's hands-on and fun and it's getting away from a lot of sitting down and doing book work. They like the excitement." (37) *Post: "Students say they liked my class because they got to learn with one another, worked cooperatively with one another, and they had turns having a role and doing jobs with one another." (37)*	Pre: "A good learner is positive, giving positive answers, and loves to be in the science lab." (13) *Post: "Helping them to question and think creatively with their peers, this can as they get older continue to help them think creatively, help them work with their peers, learning together and share thoughts and ideas with one another." (20)* Pre: "As a teacher, you don't give up on students. You may not see the actual outcome right then and there. But it's there and in due time it will come." (21)	Pre: "I believe my main strengths as a teacher, are more or less as a model. Teachers were models for me, so I'm sort of picking up what they have given me and doing the same thing for my children." (39) Pre: "I need to improve working with high achievers. You know giving them what they need as well as the low achievers." (40) *Post: "I feel that my improvement could be working with children in cooperative groups and putting children to work together to manage and help each other improve on different areas." (40)*

mentor (she sees this as her greatest strength) and pictured good learners as motivated and positive. Marie felt that the learning in her classroom could be transferred to other subjects within students' regular classroom and be shared with students' parents. Also, she stated that helping students learn to question and think creatively could help them later in life. Her greatest learning experience was that a teacher should never give up on students, "you may not see the actual outcome then and there." She's tried to model that learning experience by helping students realize that you don't always have an answer to a question immediately, it may take time. She expressed a desire to improve working with high achievers (providing enrichment) and she'd like to improve her ability to create and monitor cooperative learning groups. Marie's pre- and post-average for philosophy of teaching wobbled between conceptual and early constructivist with an average of 3.4. PT excerpts for Marie are located in Table 12.

Constructivist Learning Environment Survey - CLES analysis.

Marie's CLES scores are exhibited in Figure 8 (see Appendix F.3 for calculations). Her pre (31) and post (33) Personal Relevance scores indicated that she held a high agreement with the scale and emphasized linking school science with students' everyday experiences. Her pre (21) and post (24) Critical Voice scores were both in the range of high intermediate agreement indicating that students were sometimes but not always are encouraged to question the teacher's plans and methods and to express concerns about impediments to their learning. Her pre (22) and post (26) Shared Control scores increased notably within the high intermediate agreement range, indicating that students are sometimes but not always invited to: participate in designing their own learning activities; determine assessment criteria; and negotiate the norms of the

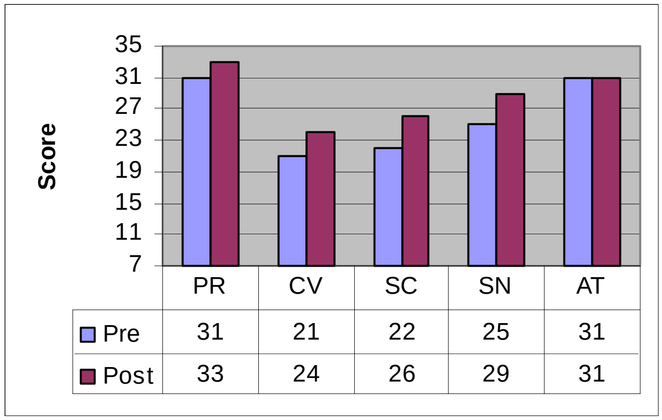


Figure 8. Marie's CLES Scores.

classroom. Her Student Negotiation scores increased notably from a level of high intermediate agreement for the pre assessment (25) to a level of high agreement for the post assessment (29). This indicates that she offered more opportunities after participation in the PI course for students to: explain their ideas to other students; make sense of other students' ideas; and reflect on the viability of their own ideas. Her pre (31) and post (31) Attitude Scale scores were in the range of high agreement indicating that she felt students: anticipated the activities within her classroom; found the activities worthwhile; and understood and enjoyed the activities.

Science Teaching Efficacy Belief Instrument - STEBI analysis.

Marie's Personal Science Teaching Efficacy Belief (PE) subscale scores for the pre and post assessments were in the high efficacy category with 53 points and 52 points respectively (max=65 points). Her Outcome Expectancy (OE) subscale scores for the pre and post assessments decreased notably from 46 to 40 points (max=60 points), from a

high OE to an average OE, indicating that she had less confidence in her teaching ability to create desirable outcomes. See Appendix G.2 for scoring calculations.

Reflective journal and interview questions.

During the PI course, Marie wrote two journal entries regarding a change in her perception of teaching and a desire to incorporate inquiry-based instruction.

5/23/03 Journal response to textbook reading.

"I did not realize that I was doing cookbook science teaching. Now that I realize what inquiry is I'll begin the school year with guiding the students into inquiry using both teacher-initiated and student-initiated inquiries. I know now that you can incorporate inquiry into a lesson by adding several extension questions for students to investigate on their own. This year I will slowly introduce inquiry lessons using a concept map."

6/13/03 Response to completing the STAM Matrix analysis of teaching.

"I completed my descriptions of teaching styles. From my findings, I have more of a transitional/conceptual style with some early constructivist. The Matrix (STAM) took me about 3 to 4 hours to complete, but it did give a great wealth of information afterwards. It's a great tool for preservice as well as experienced teachers like myself trying to improve the effectiveness of children's learning. The STAM is also helpful in that it gives a clearer picture of teacher's and students' actions. I would like to improve my relationship with the student as far as presenting activities to the students. I would like to think out of the box and embrace the inquiry approach."

During her post-interview (2/4/04), Marie provided additional insights regarding her experiences using the STAM Matrix and her desire to teach constructively rather than didactically, which prior to the PI course was the only type of science instruction to which she had been exposed.

"It gave me a way to look back on my teaching, to evaluate my teaching process because I know I did a lot of cookbook style instead of letting the children be more creative, more open-minded on their own. The biology class helped me to learn that children have a lot of creativity. I learned that I needed to let them work together as a team and bring up their own ideas. The observation tool was a long process, but through it I really learned that I was more of a didactic teacher rather than a constructivist. And I'm learning through that process to be more of a constructivist teacher, to let the children feel their way through the process instead of just handing them everything. Because, you know, when I was growing up in high school the teacher always taught that it's there, you learn from what I tell you, and it's not that. Let them be creative, let them learn, and they

will feel better about their learning. I think that they will take that with them, that they can do this on their own, because they've learned from their teacher that has motivated them to learn on their own instead of just being given everything."

Marie also commented during her post-interview that she believed that before you can teach with a particular style of teaching you have to have experience learning with that style.

"So we were doing inquiry-based learning and it was a great process because I learned how to learn from my peers and how we can learn from one another. You have to experience it, then you can be more open-ended and allow the student to experience it too."

Summary of Marie's results for research question two.

TPPI analysis of Marie's pre and post Student Actions (SA) and Philosophy of Teaching revealed that she held beliefs that wobbled between conceptual and early constructivist. However, her behaviors as described in Section II were between didactic and transitional for the pre-STAM SA observations and between transitional and conceptual for her post-STAM SA observations. Her beliefs regarding science instruction were more constructivist than her actions.

Marie's CLES scores increased notably for two subscales, shared control (22 to 26) and Student Negotiation (25 to 29), both within the high intermediate or high agreement range. Her self-rated scores for the Critical Voice Scale (CV) most closely correlated with her behaviors. With a CV score ranging from 21-24 she indicated she gave students opportunities to voice their opinions "sometimes." Her scores for the other four scales revealed her belief that she implemented constructivist behaviors "often" which did not correlate with her behaviors.

Marie felt highly efficacious in her ability to teach science as revealed by her STEBI, Personal Science Teaching Efficacy Belief scale scores. However, her beliefs in her ability to create desirable outcomes changed from a high to an average expectancy. Marie's journal responses indicated that after participation in PI course readings and activities she became aware that she had always taught didactically (primarily because that was the way she learned science) and expressed a desire to incorporate more constructivist styles of teaching.

IV. Research Question Three Analysis

"Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

Interview analysis.

Interview analysis for Research Question three includes the analysis of the three questions listed in Table 4 for Teacher and Content. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher and Content can be located in Appendix C.4. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Marie expressed teacher-centered to conceptual to student-centered styles for Teacher and Content (TC) prior to and at the completion of the PI course. Marie's TC excerpts can be located in Table 13. Before the PI course she commented that science was inquiry, curiosity, and new learning about the whole world; while after the class she

Table 13. TPPI Interview Codes and Transcript Statements for Marie (T1) Pre and Post - Question Three.

Style	Teacher and Content (TPPI - 14, 28, 34)
A	Pre: "To me science is new learning. It is a facet that stems off to all areas. It could be inquiry learning, it could be curiosity, it could be just the whole world." (14) (*Post: I don't know why I said inquiry learning before, because I didn't know what it was then*.)
B	Pre: "Science is a great tool for any child. I know when they experiment they want two things to be together and actually come out like they expected. But you don't have to, you don't always have to have it come out that way." (28)
C	Pre: "Physical, earth, and life science - all the science facets are important. We try to go by the curriculum." (34)
D	Pre: "I like science because I can do things with the hands. You can see what you've actually done through experimentation. You can always guess through science." (28)

stated, "I don't know why I said inquiry learning before, because I didn't know what it was then. She viewed science as a tool in which, "you can do things with your hands and see what you have accomplished." Marie felt that the science curriculum content including physical, earth, and life science were important areas for students to understand. Marie's pre and post TC averages wobbled between transitional and conceptual with an average of 2.3.

When asked to define inquiry and describe an experience teaching by inquiry, Marie described what would be considered an activity or the "cookbook" method (teacher-designed experiment and question) prior to and after participation in the PI course (excerpt A - definition; excerpt B - definition and experience teaching; excerpt C - experience teaching). She described experiences in which she has designed the experiment but the students explained what happened (Excerpt A - food coloring and Excerpt C - paper cup and water experiment) or students predict (Excerpt B - Fast Plants) what will happen.

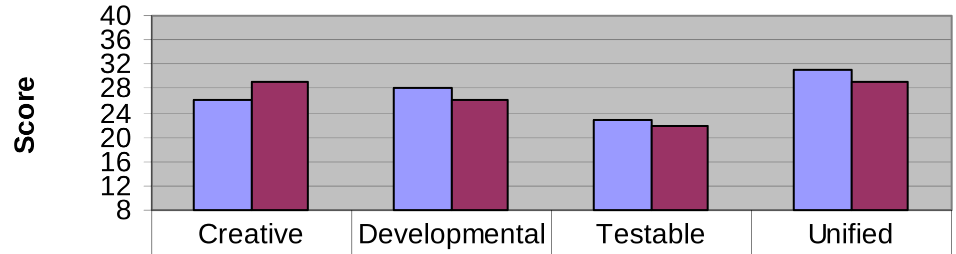
Excerpt A: 3/13/03 (Pre-interview) "Curiosity, um, not actually telling the child what the endpoint is. Letting them find out themselves what it's going to be. And then they come back and explain what they did and how they came to that conclusion and all. Just like if you had some ice and you put color in it, and let that child actually figure out how that happened without you telling him. So, they are doing it on their own and then you are sitting down together to figure out the process of how it actually happened."

Excerpt B: 2/4/04 (Post-interview) "With the fast plants, the children didn't know what the fast plants were or what would be at the end point. So we started out with one little seed and then we came up with the question, how many seeds will you get from one seed? So we started in the beginning with a seed and then at the end process they found out that they can come up with many seeds from one seed. Planting one little seed in the ground will produce many seeds. So they were curious what would happen, the beginning point. So scientific inquiry is curiosity, creativity, working together, motivating each other to come up with answers." (*Note: The Fast Plant lesson was observed by the researcher and the question and experimental design was given to the students by the teacher.)*

Excerpt C: 3/13/03 (Pre-interview) "We did an experiment with a cup and paper and the child had to dump the cup down in water and actually the paper didn't get wet up in the cup. The child did the experiment and they actually had to tell me why they think the paper was dry."

Modified Nature of Scientific Knowledge Scale - MNSKS analysis.

Marie's pre and post MNSKS scores, Figure 9, varied slightly from pre to post assessment; however, there does not appear to be a significant difference between the two scores (see Appendix H.2 for calculations). She held views above the neutral point toward the currently accepted view of the Nature of Science for all subscales with the exception of the Testable scale. The Testable scale reflects that "scientific knowledge is capable of empirical test" (Meichtry, 1992). Marie's Total MNSKS Scale Score was 108 and 106 for the pre and post assessment respectively. A Total Scale Score between 97 and 160 is within the accepted view of the Nature of Science.



	Creative	Developmental	Testable	Unified
Pre	26	28	23	31
Post	29	26	22	29

Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 9. Marie's MNSKS Scores.

Constructivist Learning Environment Survey - CLES analysis.

Marie's pre (24) and post (24) Scientific Uncertainty Scale scores were in the range of "sometimes to often." This indicates that Marie often but not always provides opportunities for students to learn that scientific knowledge is: evolving and provisional; shaped by social and cultural influences; and arising from human interests and values.

Reflective journal and interview questions.

Marie did not respond to any reflection questions regarding this research question; however, she addressed scientific literacy issues during her post interview (2/4/04). The following excerpt discusses the nature of collaborative research in science.

"Being in the biology class this summer, really helped and motivated me to bring what I learned from the summer class to my children because I felt that it was a great learning tool. The teacher just gave us a little thing and didn't tell us what it was. We had to figure out ourselves what and we used tools, the microscope, hand lens, and all, to figure it out and that was a wonderful way because the teacher didn't stand in our way of learning, we learned on our own. He was more or less a motivator to help us to stay in there and continue learning. I didn't actually know what it would be all about, you know, starting from a seed. We actually got to see the seed and we got to put it in different

things that I didn't know that we could and get it to grow. There are many things that you can learn from each other just doing one little small thing with a seed."

Summary of Marie's results for research question three.

Analysis of Marie's pre and post TPPI Teacher and Content beliefs revealed scores ranging between transitional and conceptual. Her MNSKS scores did not vary notably between pre and post assessment; however, her score on the testable scale was slightly below the neutral score and toward an unaccepted view of the Nature of Science. Her CLES Scientific Uncertainty subscale scores also did not vary noticeably from pre to post assessment. She indicated that she often gave students opportunities to view science as tentative. One of her journal responses revealed that she valued the collaborative Nature of Science she experienced as part of working in groups within the PI course and expressed a desire to have her students work collaboratively. The same journal entry also described an observation of the teacher as a facilitator within inquiry-based activities and wished to use this practice as well.

V. Research Question Four Analysis

> "Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

Mentoring Efficacy Questionnaire - MEQ analysis.

Marie's pre MEQ score of 82 (out of 100) points decreased slightly to a post-score of 80 points (see Appendix I.2 for calculations), both of which were in the high mentoring efficacy category. She indicated that she agreed she was confident in helping a protégé implement inquiry-based science instruction prior to the Project INQUIRE

course (Question 20); however, after the course she was uncertain about her ability to mentor protégés in this type of instruction.

Prior to and at the completion of the course, Marie indicated her greatest strength as a science mentor as providing workshops for hands-on lessons. Her greatest challenge before the course was "making sure the mentee understands all the science standards and concepts"; while after the course she indicated the greatest challenge as "working with a teacher or child that resists being helped."

Reflective journal questions.

Marie wrote one journal entry regarding mentoring teachers to use inquiry-based instruction.

7/18/03 "In mentoring other teachers I would love to offer an inservice on inquiry-based learning to help teachers think about science and look at science in a different way - Inquiry-based - working cooperatively with children, having open minds to a way of thinking about science. You know, when we think of science we think its hard work but it's not. You know, if we just let the children think creatively about different subjects, we can make our work much easier. And we don't always have to go out and find elaborate things that we feed to the children, just simple things that they can work with and approach learning in a simple way. I think that inquiry-based is a wonderfully creative tool to get the children to learn and if we can maybe help other teachers to learn that way they can, in turn, teach that way to their children. Because I think it starts with us learning and then we can motivate our children to learn as well. So I think an inservice would be a great way to start to motivate teachers. I would start out over a six-weeks time frame and let them take that part to the classroom and then come back and work with them again because it would take maybe over a year's time to get them to do it and you couldn't do it in maybe two or three weeks. Do something simple with the teachers after school or during an inservice day and then give them time to take it back to their classrooms. It takes time."

Summary of Marie's results for research question four.

When asked how she would describe herself as a teacher during the pre-interview, Marie used the term "mentor" referring to other teachers as well as the students. Her Mentoring Efficacy Questionnaire, pre and post assessment results, indicated that she felt

highly efficacious in mentoring other teachers. She expressed comfort in her ability to mentor teachers to use inquiry-based instruction prior to PI participation; however, after taking the course she expressed uncertainty. Her journal reflection revealed she realized that training and mentoring other teachers to use inquiry-based instruction would take time (approximately a year to change their practices).

VI. Participant Summary

Table 14 is a data matrix for Marie that provides an overall picture of her results for the Project INQUIRE assessments. Marie's beliefs were more constructivist than her behaviors. The TPPI and CLES instrument analysis revealed that she held constructivist beliefs prior to and after PI participation. However, the additional interview questions regarding her definition of inquiry and her experiences learning in an inquiry-based manner revealed that she understood she was teaching didactically prior to PI participation. She expressed a desire to teach more constructively and she exhibited a change from more teacher-centered instruction prior to PI participation to conceptual teaching after participation. Although she was teaching conceptually after PI instruction she felt that she was teaching constructively. One possibility for the discrepancy between her beliefs and actions was that she was not able to participate in the full course (due to illness); she missed the fall semester portion in which lesson plans were created and discussed as part of the class.

Marie held a high Personal Science Teaching Efficacy belief; however her beliefs in her ability to make a difference in student's learning changed from a high to an average expectancy after the course, as measured by the STEBI. Her views regarding the nature of science did not change noticeably due to course participation. She did not hold beliefs

Table 14. Project INQUIRE Data Matrix - Marie (T1).

Teacher Information: K-2 Science Specialist - Teaches in a science lab at a math/science magnet school; 28 years teaching experience										
Question One: Do teachers who complete Project INQUIRE change their instructional practices?										
STAM[a] Averages T=Teacher S=Student	Content		T. actions		S. actions		Resources		Environment	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	2.3	2.9	2.5	2.6	1.6	2.9	3	3.3	1.3	2.3
Total STAM Summary	Pre: 2.2 close to Transitional					Post: 2.8 close to Conceptual				
TPPI[a] - Teacher Actions	Pre		Avg.: 2.5		Transitional/Conceptual					
	Post		Avg.: 4.0		Early Constructivist					
Question Two: Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction?										
TPPI[a] - Student Actions	Pre		Avg.: 3.2		Conceptual/Early Constructivist					
	Post		Avg.: 3.4		Conceptual/Early Constructivist					
TPPI[a] - Philosophy of Teaching	Pre		Avg.: 3.4		Conceptual/Early Constructivist					
	Post		Avg.: 3.4		Conceptual/Early Constructivist					
CLES -	Pre		Post		*Scores:* 7-13 = Low Agreement; 14-20 = Low Intermediate; 21-27 = High Intermediate; 28-35 = High					
Personal Relevance	31		33							
Critical Voice	21		24							
Shared Control*	22		26							
Student Negotiation*	25		29							
Attitude	31		31							
STEBI -	Pre		Post		*PE Scores: 13-30 = Low; 31-48 = Average; 49-65 = High efficacy* *OE Scores: 12-28 = Low; 29-44 = Average; 45-60 = High expectancy*					
Personal efficacy-PE	53		52							
Outcome expectancy-OE*	46		40							
Questions Three: Do teachers who complete Project INQUIRE change their understanding of scientific literacy?										
TPPI[a] - Teacher and Content	Pre		Avg.: 2.3		Transitional/Conceptual					
	Post		Avg.: 2.3		Transitional/Conceptual					
MNSKS:	Pre		Post		*Scores:* 8-23 = Unaccepted view (32-95 - Total); 24 = Neutral view (96 - Total); 25-40 = Accepted view (97-160 - Total)					
Creative	26		29							
Developmental	28		26							
Testable	23		22							
Unified	28		29							
Total	108		106							
CLES - Scientific Uncertainty	Pre: 24		Post: 24		*See Scale Scores in question two.*					
Inquiry - Definition and Experience Teaching (T) or Learning (L)	Definition Pre		Experience Pre (T) & (L)		Definition Post			Experience Post (T)		
	Activity		Activity		Activity, but showed a shift in understanding			Activity		
Question Four: Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues?										
Mentoring Efficacy	Pre		Post		*Scores:* 20-40 = Low; 41-60 = Low Intermediate; 61-80 = High Intermediate; 81-100 = High					
Total	82		80							
Question #20[b] *	Agreed		Uncertain							

Note: *=notable change. [a]TPPI & STAM scale: 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist. [b]Did participant rate self as confident in ability to mentor protégé with inquiry-based instruction?

consistent with the current accepted NOS understanding that science is capable of empirical test. Her perceived efficacy toward mentoring colleagues to use inquiry-based instruction decreased after course participation.

Case Study T2 - Tee Jay

I. Basic Demographic Information

Tee Jay, a non-Hispanic White female, was a novice teacher in her 3rd year of teaching during the 2002-2003 school year. Tee Jay taught all subjects including reading, language arts, math, spelling, science, social studies and writing to a self-contained group of 3rd grade students during the 2002-2003 school year at an inner-city elementary school. She transferred to teach a self-contained group of 5th grade students during the 2003-2004 school year at the same school. Her non-teaching assignments included bus duty, building-level technology coordinator, mentor team coordinator, leadership team, and assistant science coordinator. She indicated spending 3 hours per week for science preparation prior to the PI course and 4-5 hours per week after participation.

Tee Jay had attended the state science teacher conference within the past year, prior to participation in the PI course. She attended a workshop conducted by Max Thompson designed to help teachers incorporate diverse teaching strategies and a 30-hour summer, science workshop sponsored by the University of Tennessee. She was a member of the National Science Teachers' Association, the Tennessee Science Teachers' Association, and the National Education Association. She had received Urban IMPACT's mentor training and was a member of her school's mentor core team.

The demographics of the two classes that were observed for the pre- and post-observations are described in Table 15. She had a total of 18 students in each of the pre and post observations. Tee Jay's school serves Kindergarten-5th grade students, of which 90.1% are economically disadvantaged. The demographics of the student body are 56.2% White, 36.1% African American, 6.5% Hispanic, 0.5% Asian, and .7% Native American.

II. Research Question One Analysis

"Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

STAM analysis.

Tee Jay's STAM Video Portfolio for pre and post observations can be found in Figure 10. The Video Portfolio provides an overview of the participant's instruction as well as a description of the style observed for each of the 22 teaching aspects of the STAM. Tee Jay's summary STAM scores for pre and post observations are located in Table 16 and her numerical averages for the five categories of the STAM matrix are located in Figure 11 (see Appendix K.1 for summary STAM scores and K.2 for average calculations).

Table 15. Tee Jay's Class Demographics Pre and Post Observations (T2).

	Males		Females	
	Pre	Post	Pre	Post
African American	4	5	6	3
Hispanic				1
White	7	4	1	5
Totals	11	9	7	9

STAM Pre-Observations
OVERVIEW: The focus of these lessons was on the water cycle. Day one included a review of reading from their textbook regarding an introduction to the water cycle; a teacher demonstration of filling cups with water and placement in windows to observe evaporation over time; and a continuation of textbook reading. Day two included observations of the cups in the windows; student creations of *Dinah Zike* graphic organizer pyramids on which students were to draw and describe the parts of the water cycle; continuation of textbook reading; and answering questions at the end of the textbook section. Day three (which was the first day students returned after Spring Break) included a water cycle review discussion; student creations of *Dinah Zike* graphic organizer display boards on which students were to describe and draw about the parts of the water cycle; and students completed an "exit ticket" on which they were to write the 3 parts of the water cycle from memory. The classes are teacher-directed and the teaching is best described as transitional to conceptual. Didactic - 1; Transitional - 6.5; Conceptual - 14.5[a]
CONTENT: 1B, 1C[b]. The content stressed during reviews, discussions, and demonstrations tended to be explanatory with conceptual content organized around key ideas. The content stressed during textbook reading and textbook assignments tended to be descriptive with concepts and factoids given equal emphasis. 2C. Examples and connection made by teacher to real world events, related ideas, and key ideas of the water cycle (i.e. boiling water for cooking). 3C. Limits, exceptions, and alternate interpretations are presented as part of the content (i.e. Where does water come from?) 4B. No explicit mention of how we know. Processes of science (observation, inference, experiment, etc.) are not integrated with content.
TEACHER'S ACTIONS: 5C. Rich repertoire of teacher-centered teaching methods including review, demonstrations, reading textbook, creating graphic organizers, and book work. 6C. Demonstrations and hands-on activities that are conceptually focused. "Answers" generally know ahead of time. 7C. Teacher-student interaction about correctness of students' knowledge of conceptual content. 8C. Teacher's questions are directed toward knowledge of scientific concepts and their connections and applications. They do not build on students' responses. 9C. Assessment includes frequent checking, in addition to tests & quizzes of student's knowledge. 10B. Assessment is used for checking student's knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12C. Several forms of writing and other representation of ideas are used (graphic organizers, exit ticket, book questions). Most are reconfigurations of information provided. 13A, 13B. There were a few student questions about procedure. 14A, 14B. Student-student interaction is rare. In some cases student interaction is regarding procedure. 15C. Students volunteer some examples related to class activities. 16C. Students accept procedures and role.
RESOURCES: 17C. Multiple resources (book, student-use of bulletin board, demonstration materials, graphic organizer materials) are used. 18C. Resources are related to content and illustrate ideas. 19C. Access to resources controlled by teacher, but there is some discussion of access with students.
ENVIRONMENT: 20B. The environment is teacher-controlled. Little sharing of decision making with students. 21B. Some teaching aids displayed, but may not be related to content. 22B. Students' work displayed is typically similar for all students.
OTHER: Science is taught for 50 minutes to an hour on Tuesday, Thursday, and Friday. Students are seated at desks in groups of four throughout the room (however, 2 students have individual seat assignments).

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 10. Summary of Video Portfolio - Tee Jay (T2).

STAM Post-Observations
OVERVIEW: The focus of these lessons was ecosystems. Day one included a student journal reflection of what it would be like to be an ant in the class ant farm; a discussion of ecosystems; a student exploration of dirt; and a student journal description of something they learned that day. Day two included a review of class discussion of living and nonliving things; a debate about whether dirt was living or not; a discussion of the debate; a textbook reading regarding ecosystems; and a student journal description of something they learned that day. Day three included a review of 2 previous class discussions; a textbook reading regarding symbiosis; student group work to answer two textbook questions; and a student journal reflection (at least a paragraph) of what they learned in the unit. The teaching is best described as conceptual to early constructivist in the areas of content and teacher and student actions. In the areas of resources and environment, the teaching is best described as transitional. Didactic - 1; Transitional - 3.5; Conceptual - 8.5; Early Constructivist - 9[a]
CONTENT: 1C, 1D[b]. On the first day and a half of observations the teacher and students negotiate understanding of key ideas of ecosystems with teacher's content emphasized. In the remainder of the observations, the content tends to be explanatory with conceptual content organized around key ideas. 2C, 2D. In the first half of the observations the teacher leads students in using examples and constructing connections to real world events, related ideas, and key ideas of concept. During the second half, examples and connections are made by the teacher. 3C, 3D. In the first half of the observations the teacher leads students to identify limits and exceptions that may generate alternate ways of representing or interpreting observations and events. During the second half, limits, exceptions, and alternate interpretations are presented as part of the content. 4C. "How we know" included in content. Teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5D. Some use of student-centered methods including group work, student writing, discussion, and debate. 6D. Investigations and hands-on activities lead by teacher and incorporate some students' ideas. 7C, 7D. In the first half of the observations there is teacher-student interaction about the clarification and usefulness of students' ideas and understanding is teacher directed. During the second half, there is teacher-student interaction about the correctness of students' knowledge of conceptual content. 8D. Teacher's questions are goal-oriented and occasionally emerge from students' responses. They are used to clarify students' ideas. 9D. There are multiple forms of assessment. Some assess students' knowledge and some assess students' understanding. 10C. Assessment is used to check students' knowledge and for preplanning. 11D. Teacher occasionally seeks students' ideas and considers them in instructional decisions, using this information to design activities.
STUDENT'S ACTIONS: 12D. Students occasionally use writing and other representations of ideas as part of developing their understanding and constructing meaning. Much is reconfiguring information provided. 13C. Student questions focus on clarification of meaning related to specific concepts or procedure. 14D. Some student-student interaction directed toward understanding and applying scientific ideas and some about procedure. 15C. Students volunteer some examples related to class activities. 16C. Students accept procedures and role.
RESOURCES: 17B. Text and small number of resources (journal, dirt exploration materials) are used, including some hands-on. 18C. Resources are related to content and illustrate ideas. 19B. Access to resources controlled by teacher.
ENVIRONMENT: 20B, 20C. Teacher-controlled and little to some sharing of decision-making with students about use of time. 21B. Some teaching aids displayed, but may not be related to content. 22A. Few examples of students' work displayed.
OTHER: Students are seated with a "Brain Buddy" in pairs throughout the room. Science and social studies are rotated and taught every other six weeks; 45 minutes to an hour daily.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 10. Continued.

Table 16. STAM Summary Scores - Tee Jay (T2).

	1A Didactic	2B Transitional	3C Conceptual	4D Early Constructivist	5E Experienced Constructivist
Content - C; Rows 1-4 Summary: Pre= 2/3 Post=3/4					
1		◘	◘ ●	●	
2			◘ ●	●	
3			◘ ●	●	
4		◘	●		
Teacher's Actions - TA; Rows 5-11 Summary: Pre= 2/3 Post= 3/4					
5			◘	●	
6			◘	●	
7			◘ ●	●	
8			◘	●	
9			◘	●	
10		◘	●		
11			◘	●	
Student's Actions - SA; Rows 12-16 Summary: Pre= 2/3 Post=3/4					
12			◘	●	
13	◘	◘	●		
14	◘	◘		●	
15			◘ ●		
16			◘ ●		
Resources - R; Rows 17-19 Summary: Pre=3 Post= 2/3					
17		●	◘		
18			◘ ●		
19		●	◘		
Environment - E; Rows 20-22 Summary: Pre=2 Post=1/2					
20		◘ ●	●		
21		◘ ●			
22	●	◘			
Total STAM Summary: ◘ Pre-Observations = 2.6; ● Post-Observations = 3.2					

Notes: Summary values written with slash indicate score wobbles within range. Teaching styles (A-E) were coded with numbers (1-5) for the purpose of calculating a numerical average displayed in Figure 11.
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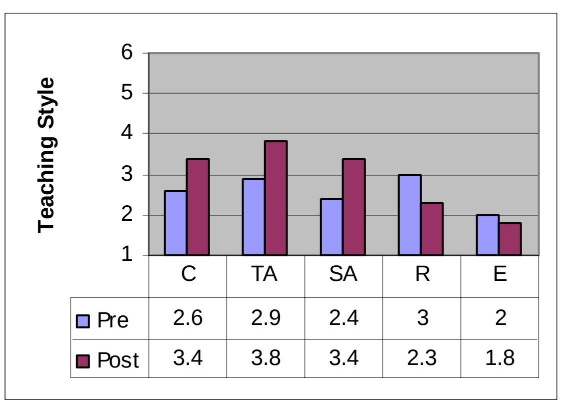


Figure 11. Tee Jay's Summary STAM Scores.

Chapter III, Stages of STAM analysis describes the method (see Appendix D.1 for Standard Operating Procedures, D.2 for Analysis Matrix, D.3 for Video Portfolio template, and Appendix J for Pre and Post STAM Records of Activities for each participant).

Interview analysis.

Interview analysis for Research Question one includes the analysis of the seven questions listed in Table 4 for Teacher Actions. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher Actions can be located in Appendix C.4.

Tee Jay expressed primarily a teacher-centered Teacher Action (TA) style prior to and at the completion of the PI course with a few student-centered comments. She preferred to teach hands-on lessons; however she felt constrained to do so by the curriculum (including a required pacing schedule), lack of resources, and student behavior. Although she felt constrained by the curriculum she used a variety of strategies and tried to address different learning styles within her lessons. She attempted to conduct more hands-on activities with the class she was teaching during the post-interview because they had much better behavior. To accommodate diverse students' needs she used "peer buddies" who could help each other understand activities. She commented that she would not let special needs participate in a debate because she did not want to subject them to failure. Tee Jay's pre-average for Teacher Action style wobbled between didactic and transitional at 1.9 and her post-average was transitional at 2.0. Teacher Action excerpts are located in Table 17.

Table 17. TPPI Interview Codes and Transcript Statements for Tee Jay (T2) Pre and Post - Question One.

	Three categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
A	Pre: "I decide what to teach based on ___ County curriculum." (18) *Post: "___ County's curriculum is tougher this year than it was before. They've broken down each skill and objective into essentials and compacted and they only want you to teach the essential skills. It's all test-based, you know. To me we are teaching to the test." (18)* Pre: "I move from one concept to the next based upon ___ County's curriculum pacing guide and it's bad because a lot of kids are left behind." (19) *Post: "Our curriculum generalist comes in and checks to make sure that we are where we need to be. If you have an honors program that comes up in the afternoon and you've missed science time, that's something that you are going to loose. I mean, it's just hard." (19)* Pre: "I try to do hands-on kinds of things with them, but there's a lack of materials and I personally cannot afford to buy the items that we need." (23) Pre: "They love doing hands-on things but at the same time when I allow them to do that it gets out of control. So I tend not to do them because I don't want my students suspended for fighting with each other or worse." (24) *Post: "Behavior is not a big issue, it's not even a drop in the bucket compared to what it was last year." (24)*	Pre: "Everything that we do is set to a pacing guide. They want us to follow it in a certain order because if a child transfers they may transfer to a class that's now teaching something that we've already taught. And I can see their point of that because our student mobility rate is so high." (25)	*Post: "There was no way that I would have let the special needs students participate in a debate, because I knew that they could not have attempted without failure." (38)*

Table 17. Continued.

	Three categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
B	Pre: "I try to hit as many of the four learning styles as I can, you know, the tactile, kinetic, auditory, and visual." (33)		
C		*Post: "The way I teach is up to me to deliver. Um, state, local, I mean they don't really affect the strategies that I use. They give me suggestions, but that's the only way that they influence, which is by being a guide or a model for the ideas." (25)*	Pre: "I modify assignments and let them copy from a peer buddy. We do a lot of oral testing and I let them listen to tapes, books on tape." (38) *Post: "My special needs students are actually not in the room at the time we schedule science. Like once or twice a week when they don't have to leave the room they get a lot of guidance from their buddies. They are partnered up with another student who they shadow. We do a lot of things orally, group work, small group, big groups, you know."(38)*
D	Pre: "According to ___ County curriculum and I look at what is relevant to them in their life. Because I think if they have some relationship to the lesson that it means more and it will retain better. And I think that if they had more experiences I could teach more." (18) *Post: "I think you can do a lot, but you really have to know your kids to be able to do it. You can really find any situation to fit if you know your kids well enough." (18)* Pre: "I have too many kids who are ADHD or oppositional that I have to almost keep them in their seats and they can't handle any stimulus. Even our special classes upset them." (23) *Post: "I have children that are more behaved than last year, more logical thinkers. They are progressed and I can give them more hands-on activities than I was before." (23)*		

SIDESTEP analysis.

On the SIDESTEP questionnaire, Tee Jay responded that she purposely asked higher order questions of girls, used wait time, and assigned heterogeneous groups to address gender equity issues. She modified assignments and tests, provided one-on-one assistance and used "oral work" to address the needs of students with special needs. She used the system-wide adopted science textbook for her class. She reported the use of group work, worksheets, discussions, projects, oral reports, homework, concept maps, and multiple choice and true/false tests to assess students' understanding before and after PI participation. She added essays, debates, and inquiry to her assessment strategies after PI participation. Her top three goals for students' learning in science included: exploration of concepts; logical thinking; and thinking about science in a different way (as endless possibilities).

Summary of Tee Jay's results for research question one.

STAM analysis revealed that Tee Jay exhibited primarily conceptual and some transitional behaviors during pre-observations with a total STAM summary average of 2.6. During post-observations, she exhibited some transitional behaviors; however, most of her behaviors were equally split among conceptual and early constructivist styles with a total STAM summary average of 3.2. Her pre summary STAM averages increased from a wobble between transitional and conceptual to a post average between conceptual and early constructivist for Content, Teacher Actions, and Student Actions; decreased from conceptual to a wobble between transitional and conceptual for Resources, and showed negligible change in the area of Environment (transitional, 2.0 to a wobble between didactic and transitional, 1.8).

Analysis of Tee Jay's TPPI interview questions (beliefs) revealed that her pre and post average for Teacher Actions (TA) showed negligible change (1.9-2.0 - didactic to transitional range). However, her behaviors changed following PI participation from a pre-STAM TA average of 2.9 (close to conceptual) to a post-STAM TA average of 3.8 (close to Early Constructivist). Therefore, she exhibited more constructivist behavior than her beliefs indicated.

III. Research Question Two Analysis

> "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

Interview analysis.

Interview analysis for Research Question two includes the analysis of the ten questions listed in Table 4 for Student Actions and Teacher's Philosophy of Teaching. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Student Actions and Teacher's Philosophy of Teaching can be located in Appendix C.4.

Tee Jay expressed statements across teacher-centered and conceptual and student-centered styles for Student Actions (SA) prior to and at the completion of the PI course. SA excerpts for Tee Jay are located in Table 18. She felt that a teacher needed to make learning relevant to students' lives, that students vary on how they best learn ("it depends on what method they prefer to use"), and that students are sometimes the best teachers of other students. She knew that students understood a concept when she saw that "light bulb effect," and when they were able to discuss the lessons and go further with the topic.

Table 18. TPPI Interview Codes and Transcript Statements for Tee Jay (T2) Pre and Post - Question Two.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
A	Pre: "I think students understand when I see that light bulb effect. When a child is struggling with something and then their eyes just light up and their mouth drops open." (30)		Pre: "I like to think I'm structured and organized. One of the parents has actually referred to me as drill sergeant. I wear that name proudly." (1)	Pre: "My main strengths are discipline, management, and paperwork." (39) *Post: "I'd say pulling off several strategies in one setting is my strength as well. That's a benefit to the students." (39)* Pre: "I'd like to improve assessment. Like if I have a lesson plan and if a student isn't catching it, I need to catch that and modify it immediately in my lesson. I'm not able to do that as well because I am so structured." (40)
B	*Post: "Not only the light bulb effect, but if they are able to discuss it." (30)*			
C	*Post: "They understand if they can manipulate and go further with the topic." (30)*		*Post: "I think the group work, cooperation, the questioning and the inquisition, is going to help them a lot outside of the classroom." (20)* Pre: "I try to do hands-on activities in the classroom." (22)	

Table 18. Continued.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
D	Pre: "I think it's up to the student how they best learn. It depends upon what method they prefer to use." (29) Pre: "Sometimes I let other students teach students, because maybe I'm not understanding why they are not understanding me, so I think sometimes children teach other children best." (29) *Post: "I think students learn best when you make it beneficial to them or relevant. Make sure they understand how it relates to their real world, no matter what strategy you use." (29)*	Pre: "I honestly think that the kids know that I care about them. I think it just has to do again, with socialization and attachment because there is not a permanent fixture in their environment. I'm the stability." (37)	Pre: "Good learners are attentive, active, participate in the lesson, in the question/answer dialogue, or they have an eagerness to find answers." (13) Pre: "I don't think academics are as valuable to them as social and survival skills. You know, it's being able to socialize with somebody that may give them what they need." (20) Pre: "The best learning experiences are those that allow me to reflect upon my own experiences. I like open discussion, hands-on kinds of things. It has to be a kind of group setting where there's trust established." (21)	

Tee Jay felt that her students valued her classroom because she cared about them and she was a permanent fixture in their environment. Tee Jay's pre-average (3.0) for SA was conceptual, while her post-average (3.3) wobbled between conceptual and early constructivist.

Tee Jay's Philosophy of Teaching (PT) was equally teacher- and student- centered prior to and at the completion of the PI course; however, she held additional conceptual views after the PI course. She described herself as structured and organized and viewed discipline, management, paperwork, and a variety of teaching strategies as her greatest strengths. She viewed the social aspects (i.e., group work and social/survival skills) of her classroom as the most valuable to students rather than the academics. Her greatest learning experiences were described as those in which she could use her hands and reflect. She tried to model these experiences by doing hands-on activities in the classroom. She would like to have improved her assessment skills by making modifications, on the spot, which was difficult for her because she was so structured. Tee Jay's pre- and post-averages for PT wobbled between transitional and conceptual styles with averages of 2.6 and 2.8 respectively. PT excerpts for Tee Jay are located in Table 18.

Constructivist Learning Environment Survey - CLES analysis.

Tee Jay's pre (28) and post (29) Personal Relevance scores were in the high agreement range, indicating that she placed a high emphasis on linking school science with students' everyday experiences (see Appendix F.3 for calculations). Her pre (28) and post (31) Critical Voice scores were both in the high agreement range as well, indicating that Tee Jay placed a high emphasis on encouraging students to question her

plans and methods and express concerns about impediments to their learning. Her pre (19) and post (28) Shared Control scores increased notably from a level of low intermediate agreement to a level of high agreement. This indicated that she emphasized more opportunities after participation in the PI course for students to: participate in designing their own learning activities; determine assessment criteria; and negotiate the norms of the classroom. Her Student Negotiation scores increased notably from a high intermediate agreement level for the pre assessment (25) to a high agreement level for the post assessment (32). This indicated that she offered more opportunities after participation in the PI course for students to: explain their ideas to other students; make sense of other students' ideas; and reflect on the viability of their own ideas. Her pre (28) and post (28) Attitude Scale scores were in the high agreement range of indicating that she felt students: anticipated the activities within her classroom; found the activities worthwhile; and understood and enjoyed the activities. Tee Jay's CLES scores are exhibited in Figure 12.

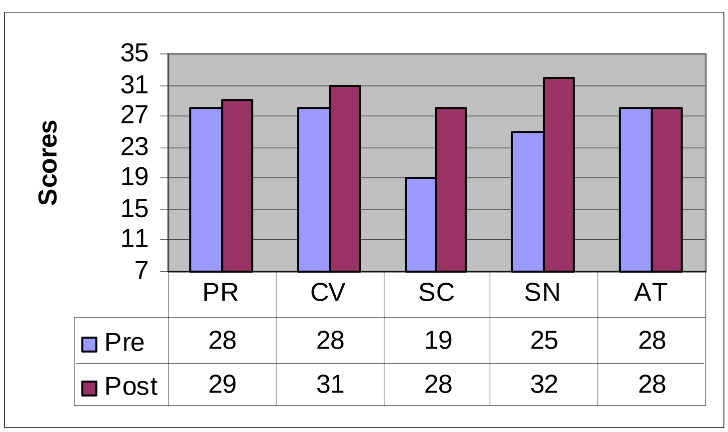


Figure 12. Tee Jay's CLES Scores.

Science Teaching Efficacy Belief Instrument - STEBI analysis.

Tee Jay's Personal Science Teaching Efficacy Belief subscale scores for the pre and post assessments were in the high efficacy category, with 53 points and 54 points respectively (max=65 points). Therefore, she was comfortable with her ability to teach science. Her Outcome Expectancy subscale scores for the pre and post assessments were in the low expectancy category, with 27 points and 28 points respectively (max=60 points), indicating that she had little confidence in her teaching ability to create desirable outcomes (see Appendix G.2 for calculations).

Reflective journal and interview questions.

Tee Jay expressed several constraints to inquiry-based teaching including student behavior (Excerpt A), teacher control of classroom, difficulty adapting curriculum, and lack of equipment (Excerpt B and C) and less emphasis on science from administration (Excerpt D). However, she eventually expressed comfort in developing inquiry-based lessons (in response to a PI course requirement - Excerpt E).

Excerpt A (5/12/03) "I enjoyed the reading, but again I will state that I don't trust my current students to be able to conduct this type of inquiry-based learning. Debating will become argument because I have so many strong-willed, loud-mouthed students. Our classroom is structured with a point system and they know the expectations, but they get out of hand often and quickly."

Excerpt B (6/17/03) "I am incredibly troubled by what is and what I believe should be. In the readings, I am able to see what I need to strive to be (in my opinion), but the teacher side of me does not allow me to feel comfortable releasing as much control as what I feel is necessary to be a true inquiry-based classroom. The curriculum that I am preparing to teach in the fall doesn't seem to lend itself to an inquiry-based environment. As I try to interpret essential questions and real life "problems" for the students to construct their inquiry, I find it hard to correlate with the textbooks that are dictated by the county. In addition, I find it an uphill battle to complete inquiry based learning when there is an immense problem with equipment that will enhance inquiry learning. Trying to remain positive is hard, because I can only do so much with what I am given....and building something from little to nothing is a very large task . While

completing the STAM analysis, I believe that it also shows what I'd like to do and what I do. My ideas are there, but implementing them is where I struggle the most."

Excerpt C (10/2/03) "I am so frustrated trying to complete my job and being required to spend my money in order to do so. I have sent donation letters and begged out the wazoo....but to no avail. When I got out my ant farm, I realized that the contents were never replaced, which means that I had to replace it on my own. It would be extremely nice to work at a school that had funds to provide us with the stuff that we need. I am tired of begging, searching, and feeling as though I am beating my head against the wall.

Excerpt D (10/2/03) "As the school year approached I heard my principal saying that we are to have 45 minutes of math and reading everyday, but we have so many breaks in our day that the reality is impossible. When I brought this to my principal's attention it was mentioned that if something had to be cut it was to be social studies and science. This really bothers me when you can teach reading and math using science and social studies....I did it last year. It was even suggested that we delete spelling from our teaching. My question is....in our quest for higher test scores what is the true weight of what we are deleting? I don't think that anyone has really thought of that. If any subject encompasses all of the disciplines it is science. I don't think I truly realized the impact until undergoing this project."

Excerpt E (10/02/03) "I was able to do it! After putting it off so long, I took a lesson from the __ County Science Curriculum and adapted it to the Five-E model. Once I got started it wasn't as hard as I thought it would be. Our librarian even assisted me in finding books that would correlate with a lesson on owl pellets and storing food. It was nice being able to consult with a colleague about this. In all honesty I don't utilize the library as much as I should. Now that this is becoming easier to adapt lessons I might be able to utilize this more. I hope that other teachers find this experience as exciting as I do and are willing to embrace this."

Tee Jay described changes in her teaching in response to the PI course in the following two interview excerpts. The first excerpt describes how it's hard to stay with a lesson plan during inquiry lessons if a teacher is going to allow students to pursue their own questions. The second excerpt describes how she felt positive about giving up some of her control of the classroom.

11/7/03 (Post-interview) "I think it's hard to follow a lesson plan with inquiry because they have so many questions and I think almost writing a lesson plan in that detail in that manner defeats inquiry because you are asking to stay on a lesson plan, but yet I had children going in different directions. And I had a choice, do I go in that direction or do I come back to the plan? And if I come back to the plan, is that true

inquiry? And so, I've struggled with that. Because is dirt living, never popped up on my lesson plan, but had I moved on back to my lesson plan, I would have quelched that in that child, or something else would have happened. But I thought, let's run with it, let's go, that was their question. It was something that was important and it spawned so much other stuff that I think it was beneficial to just let the plan go."

11/7/03 (Post-interview) "I think the course definitely switched my thinking and at the same time it's affecting the way I teach. I'm asking more of them than I did before. I mean, I think last year was very controlled with reading the book and doing a worksheet. But this year, I like the progression that I have made. I just find myself standing back and letting them do the work, letting them do the discussion, and I'm not as in control, but it could just be the group."

Summary of Tee Jay's results for research question two.

TPPI analysis of Tee Jay's pre and post Student Actions (SA) revealed that she held beliefs between conceptual and early constructivist (from 3 to 3.3). Her behaviors for SA as described in Section II were congruent with her beliefs with a pre-STAM SA average of 2.9 and a post average of 3.8, both in the conceptual to Early Constructivist range. TPPI analysis of her Philosophy of Teaching revealed scores between transitional and conceptual pre and post (from 2.6 to 2.8; close to conceptual), which revealed beliefs less congruent with her actions (considerably below the early constructivist range).

Tee Jay's CLES scores changed notably for two subscales. Her self-rated Shared Control scores increased from 19 (high intermediate) to 28 (high). Her Student Negotiation scores increased from 25 (high intermediate) to 32 (high). Journal and interview responses in which she stated that she did not feel comfortable giving up control prior to PI participation and that she was gradually giving more control to students after the course, correlated with these increases. Her scores for the Personal Relevance, Critical Voice, and Attitude subscales did not change noticeably from pre to post assessment and were in the high agreement range. Interview responses in which she

stated that it was important to make learning relevant to student's lives correlated with these subscales. Although she exhibited more teacher-centered to conceptual behaviors prior to PI participation, she exhibited more conceptual to student-centered behaviors after the course, which was more congruent with her beliefs she claimed in her CLES responses.

Tee Jay felt highly efficacious in her ability to teach science as revealed by her STEBI, Personal Science Teaching Efficacy Belief scale scores. However, she held low confidence in her ability to create desirable outcomes from teaching science. Tee Jay's journal responses indicated a concern that school administrators did not support teaching science and she expressed a concern about the lack of proper equipment for teaching science. These concerns could indicate reasons for her lack of confidence in making meaningful changes in students' science learning.

IV. Research Question Three Analysis

"Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

Interview analysis.

Interview analysis for Research Question three includes the analysis of the three questions listed in Table 4 for Teacher and Content. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher and Content can be located in Appendix C.4. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition

provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Before the PI course, Tee Jay expressed primarily a teacher-centered style for Teacher and Content (TC); while after the course, she incorporated several student-centered statements. Tee Jay's TC excerpts can be located in Table 19. She described science as exploration of everyday things, collecting and analyzing data, and learning new things. She valued the ability of science to open your mind to new things and for the ability to question. She felt that the most important science concepts for her students to learn included the skills and processes involved in conducting science. Tee Jay's pre TC average wobbled between didactic and transitional and her post-average was transitional with respective averages of 1.5 and 2.0.

Table 19. TPPI Interview Codes and Transcript Statements for Tee Jay (T2) Pre and Post - Question Three.

Style	Teacher and Content (14, 28, 34)
A	Pre: "Science is everything. It's more than just collecting data and analyzing it. To me, it's having fun, getting to play, and learning new things." (14) *Post: "I would just call it exploration. Exploration of things around us and things that we interact with everyday. You know, how things are made, how things end up the way... why things are the way they are." (14)*
B	Pre: "Science can make you think about it in a different manner you've never thought of before. So it opens your mind." (28)
C	Pre: "Recording data, comparing data, or analyzing it would probably be the most important thing in science." (34)
D	*Post: "I value that I have the ability to question. I can take it apart and put it back together if I wanted to. And just keep building on what I already know based on something else that I found out." (28)* Pre: "It's just that the collection and analyzation of data and maybe even interpreting it would be the most important." (34) *Post: "The processes involved in making something happen like an experiment. What would they have to do to figure out the answer to the question? (34)*

When asked to define inquiry Tee Jay felt that her pre-interview responses were actually describing more of an activity approach or as she referred to it, the "scientific method." Her post-interview response incorporated a description of open/full inquiry.

3/19/03 (Pre-interview) "Data collection, analyzation, interpreting, graphing, posing a question but then finding something out and having to reframe that question again, like a work in progress."

11/7/03 (Post-interview) "I'd leave my response the way it is, but I think I would put questioning in front, you know? Questioning is the basic importance for solving a problem and how do I go about it, designing experiments, to prove or to find answers to the questions that I came up with. So it's more than what is here (*reference to pre-interview response)*, because that's very cold. I mean that seems very cold, like almost it's not even inquiry what I had here from last time. It's almost like the old problem-solving process. I think inquiry is more the let's see where you're going to go. Where are your questions going to lead you? I think that's more scientific inquiry, letting your questions be the guide."

When asked to describe if she had experiences teaching by inquiry, she felt that she didn't teach with inquiry either before or after the PI course. She cited constraints of the lack of equipment, teaching the only way that she had learned in science classes, and emphases on math and reading.

3/19/03 (Pre-interview) "I mean I almost don't think that I teach by inquiry in all honesty. I would love to, I mean I would love to have the little boxes in the window where they grow plants and the students could see them, or the ant farms where they come in and journal every morning. I'd love to be able to do that, but again the funding is so horrible. I mean we don't even have magnifying glasses for the classroom. I don't think the school system wants to put the money where their mouth is."

3/19/03 (Pre-interview) "I could say I teach the way I was taught science, where you sit in your chair and just read. When I went to college, it was more of me still sitting, but watching the professors do the show. It caught my attention, but at the same time I was not active. Um, and I had several good science teachers. So, I can remember a high school biology class that we dissected a frog in. And all I can remember, is that gross smell. And to me that was so disgusting, because it's not about dissection of animals there's so much more to it. But, I was never shown that as hands-on, I was shown the gross stuff."

11/7/03 (Post-interview) "I'd love to have a science lab where my resources are always there and I had time. I feel the time restraints when you are told to push everything aside and just teach math and reading, forget everything else. You feel like, oh well, what happens if I'm teaching science and they walk in? Do they think I'm going to be frivolous, even though, I can put reading skills in through the science curriculum? I just, I don't know. It just puts a little bit of stress in there if you are teaching science and you are caught, so to speak."

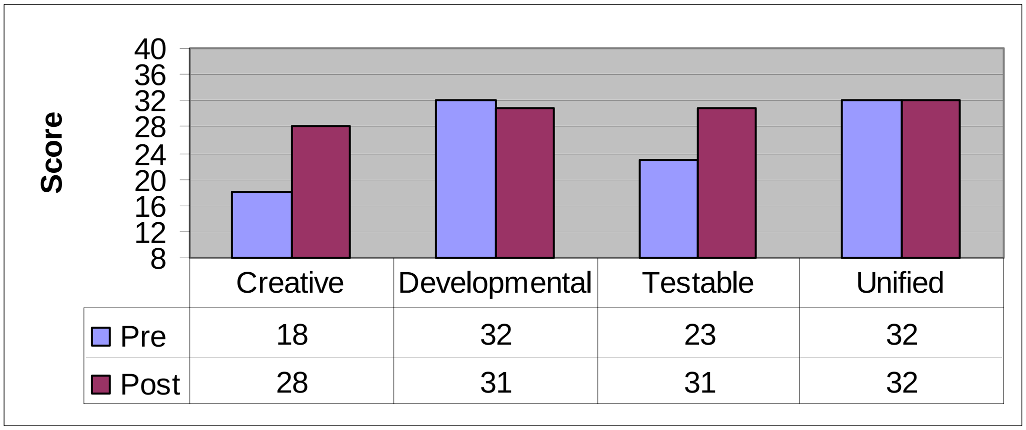
When asked to describe an experience learning by inquiry, Tee Jay described an activity-based experience in the pre-interview and then an open/full inquiry experience from the PI course in the post-interview.

3/19/03 (Pre-interview) "Well I think, I don't know if this is learning by inquiry… At the TSTA thing (*conference)*, there was that one class on fossils where they handed you a rock and they were giving you information about um fossils, and then they let you dig into your rock like an architect for, I mean an archaeologist for fossils in your rock. And I loved it. You know, I had my opinion before I walked in there and as the class progressed I changed my mind. Because when I first sat down I was like, oh my gosh, because it was heavy and archaeology kind of things and stuff I didn't know about, like fossils and time periods. And by the time I left I was having fun because I got to play with that rock."

11/7/03 (Post-interview) I think that my experience as a learner has changed just by being in that class with Dr. Hickok. I actually learned what inquiry is, um, growing the plants and designing experiments, and stuff like that, just put a different light on it. Do I teach inquiry? No, I'm not there yet. I mean I teach a little, but I don't think I'm there the whole way. I've got a long way to go.

Modified Nature of Scientific Knowledge Scale - MNSKS analysis.

Tee Jay's pre and post MNSKS scores, Figure 13, were not considerably different for the Developmental and Unified subscales (see Appendix H.2 for calculations); however, they were toward the currently accepted view of the Nature of Science (NOS). Her responses to the Creative subscale notably increased from a pre score of 18 (toward unaccepted view of NOS) to a post score of 28 (toward accepted view of NOS). Her responses to the Testable subscale also increased notably from a pre score of 23 (unaccepted view) to a post score of 31 (accepted view). Tee Jay's Total MNSKS Scale



Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 13. Tee Jay's MNSKS Scores.

Scores increased notably from 105 to122 (above 96 is within the accepted view of the NOS).

Constructivist Learning Environment Survey - CLES analysis.

Tee Jay's pre (23) and post (25) Scientific Uncertainty Scale scores were in the range of "sometimes to often." This indicated that Tee Jay often but not always provided opportunities for students to learn that scientific knowledge is: evolving and provisional; shaped by social and cultural influences; and arises from human interests and values.

Reflective journal questions.

Tee Jay described insecurities about content knowledge preparation (Excerpt A). She wrote a response to a textbook reading regarding how it influenced her definition of inquiry (Excerpt B). She described an experience in which her mealworms were dying as an opportunity for students to learn about experimental design and experiments with living organisms (Excerpt C).

Excerpt A (4/21/03) "The question about designing an experiment with the pond plant really bothers me. For the first time I felt unsure about my ability in the content. This 'eye-opener' has made me open my mind to learning new possibilities with this class and the group." (*Reference to being asked to design an experiment given certain conditions in class.)*

Excerpt B (5/12/03) "My definition of inquiry-based learning is encapsulated within the textbook definition, especially the segment on inquiry being based in imagination. I am looking forward to being able to conduct more inquiry-based lessons with my students next school year."

Excerpt C (6/4/03) "I began rereading all of the materials thinking that their (*mealworms)* dying was due to something I was or wasn't doing correctly. After rereading I realized that it was my doing. If this had been happening in my classroom, this would be a prime opportunity to explain to students about experiments (their successes and failures), working with live specimens, and the life cycle of an insect. At this moment I am down to about 6 mealworms and I am curious about how this would affect a classroom experiment."

Summary of Tee Jay's results for research question three.

Analysis of Tee Jay's pre (1.5) and post (2.0) Teacher and Content beliefs revealed scores ranging between didactic and transitional. Her MNSKS Creative and Testable scores improved to the range within the accepted NOS view after PI participation, while her Developmental and Unified scores were already in the accepted range. Her CLES SU subscale score indicated that she sometimes to often gave students opportunities to view science as tentative. Tee Jay's definition of inquiry changed from an activity/cookbook perspective to that of agreement with the definition of open/full inquiry that was used in the course. She did not feel confident teaching with inquiry before or after the class; although, she improved her confidence in planning inquiry-based lessons. She cited limited experiences learning by inquiry, lack of equipment, and emphases on math and reading as reasons for low confidence in teaching with inquiry-based instruction.

V. Research Question Four Analysis

"Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

Mentoring Efficacy Questionnaire - MEQ analysis.

Tee Jay's pre MEQ score of 74 (out of 100) points increased slightly to a post-score of 78 points, both of which were in the high intermediate mentoring efficacy range. She indicated that she was uncertain if she could help a protégé implement inquiry-based science instruction prior to the Project INQUIRE course (Question 20); however, after the course she was confident in her ability to mentor protégés in this type of instruction.

Prior to the PI course, Tee Jay indicated her greatest strength as a science mentor as having an "open mind and willingness to take risks" and her greatest challenge as "feeling confident enough in science to become a mentor or someone that everyone looks up to as an expert". After taking the PI course, she indicated her greatest strength as "creating inquiry-based lessons" and her greatest challenge as "materials/resources."

Reflective journal questions.

Tee Jay developed a science committee within her school to address mentoring teachers in using inquiry-based methods. The following journal entry describes the committee's efforts to catalog school resources and develop inquiry-based lesson plans.

10/2/03 "In my quest to finally turn everyone on the staff to science and the five E's, I developed a science committee for our school. The committee is comprised of one person from each grade level. Our first task is to construct a directory of science materials within the school. That way everyone has access to what they need to teach science. Our next item on our agenda is to take a current lesson from the curriculum and modify it to the five E component lesson plan. I've been copying the articles that were passed out

during class and guiding the committee to develop the five E components. Once modified, I asked that each grade level explain their lesson to a group...either the school staff by choice or the science committee themselves."

Summary of Tee Jay's results for question four.

Tee Jay's Mentoring Efficacy Questionnaire results indicated that she was confident mentoring other teachers from pre to post assessment (in the high intermediate range). She was uncertain about her ability to mentor teachers in using inquiry-based instruction prior to PI participation; however, she expressed comfort after taking the course. One of Tee Jay's journal reflections described a science committee she developed as an effort to engage the school with inquiry-based science.

VI. Participant Summary

Table 20 is a data matrix for Tee Jay that provides an overall picture of her results for the Project INQUIRE assessments. Tee Jay's behaviors became more constructivist after PI course participation. Her beliefs as measured by the interview and the STEBI, Outcome Expectancy subscale were less constructivist than her behaviors; however, her beliefs as measured by the CLES and STEBI, Personal Teaching Efficacy subscale were more congruent with her emergent constructivist behaviors. She expressed concerns about being "caught" teaching science when there is such a high emphasis placed on teaching and raising scores in reading and math. Although she valued science as a subject, her concerns as a professional teacher and efforts to meet the demands placed upon her by administration as well as the lack of resources weighed heavily on her beliefs as expressed in several journal and interview responses.

Tee Jay's knowledge of scientific literacy issues improved after PI participation. In particular, her knowledge regarding the creative and testable aspects of the NOS

Table 20. Project INQUIRE Data Matrix - Tee Jay (T2).

<table>
<tr><td colspan="11">Teacher Information: Pre: 3rd grade; Post: 5th grade; 3 years teaching experience</td></tr>
<tr><td colspan="11">Question One: Do teachers who complete Project INQUIRE change their instructional practices?</td></tr>
<tr><td rowspan="3">STAM[a] Averages
T=Teacher
S=Student</td><td colspan="2">Content</td><td colspan="2">T. actions</td><td colspan="2">S. actions</td><td colspan="2">Resources</td><td colspan="2">Environment</td></tr>
<tr><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td></tr>
<tr><td>2.6</td><td>3.4</td><td>2.9</td><td>3.8</td><td>2.4</td><td>3.4</td><td>3</td><td>2.3</td><td>2</td><td>1.8</td></tr>
<tr><td>Total STAM Summary</td><td colspan="5">Pre: 2.6 Transitional/Conceptual</td><td colspan="5">Post: 3.2 close to Conceptual</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 1.9</td><td colspan="6">Didactic/Transitional</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.0</td><td colspan="6">Transitional</td></tr>
<tr><td colspan="11">Question Two: Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction?</td></tr>
<tr><td rowspan="2">TPPI[a] - Student Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 3.0</td><td colspan="6">Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 3.3</td><td colspan="6">Conceptual/Early Constructivist</td></tr>
<tr><td rowspan="2">TPPI[a] - Philosophy of Teaching</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.6</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.8</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td rowspan="6">CLES -
Personal Relevance
Critical Voice
Shared Control*
Student Negotiation*
Attitude</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="6"><u>Scores</u>:
7-13 = Low
14-20 = Low Intermediate
21-27 = High Intermediate
28-35 = High</td></tr>
<tr><td colspan="2">28</td><td colspan="2">29</td></tr>
<tr><td colspan="2">28</td><td colspan="2">31</td></tr>
<tr><td colspan="2">19</td><td colspan="2">28</td></tr>
<tr><td colspan="2">25</td><td colspan="2">32</td></tr>
<tr><td colspan="2">28</td><td colspan="2">28</td></tr>
<tr><td rowspan="3">STEBI -
Personal efficacy-PE
Outcome expectancy-OE</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="3"><u>PE Scores</u>: 13-30 = Low; 31-48 = Average; 49-65 = High efficacy
<u>OE Scores</u>: 12-28 = Low; 29-44 = Average; 45-60 = High expectancy</td></tr>
<tr><td colspan="2">53</td><td colspan="2">54</td></tr>
<tr><td colspan="2">27</td><td colspan="2">28</td></tr>
<tr><td colspan="11">Questions Three: Do teachers who complete Project INQUIRE change their understanding of scientific literacy?</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher and Content</td><td colspan="2">Pre</td><td colspan="2">Avg.: 1.5</td><td colspan="6">Didactic/Transitional</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.0</td><td colspan="6">Transitional</td></tr>
<tr><td rowspan="6">MNSKS:
Creative*
Developmental
Testable*
Unified
Total*</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="6"><u>Scores</u>:
8-23 = Unaccepted view (32-95 - Total)
24 = Neutral view (96 - Total)
25-40 = Accepted view (97-160 - Total)</td></tr>
<tr><td colspan="2">18</td><td colspan="2">28</td></tr>
<tr><td colspan="2">32</td><td colspan="2">31</td></tr>
<tr><td colspan="2">23</td><td colspan="2">31</td></tr>
<tr><td colspan="2">32</td><td colspan="2">32</td></tr>
<tr><td colspan="2">105</td><td colspan="2">122</td></tr>
<tr><td>CLES - Scientific Uncertainty</td><td colspan="2">Pre: 23</td><td colspan="2">Post: 25</td><td colspan="6">See Scale Scores in question two.</td></tr>
<tr><td rowspan="2">Inquiry - Definition and Experience
Teaching (T) or Learning (L)</td><td colspan="2">Definition Pre</td><td colspan="2">Experience Pre (L)</td><td colspan="3">Definition Post</td><td colspan="3">Experience Post</td></tr>
<tr><td colspan="2">Scientific Method</td><td colspan="2">Activity</td><td colspan="3">Open/Full inquiry</td><td colspan="3">(L) - Open inquiry
(T) - minimal and guided</td></tr>
<tr><td colspan="11">Question Four: Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues?</td></tr>
<tr><td rowspan="3">Mentoring Efficacy
Total
Question #20[b] *</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="3"><u>Scores</u>:
20-40 = Low; 41-60 = Low Intermediate; 61-80 = High Intermediate; 81-100 = High</td></tr>
<tr><td colspan="2">74</td><td colspan="2">78</td></tr>
<tr><td colspan="2">Uncertain</td><td colspan="2">Agreed</td></tr>
</table>

Note: *=notable change. [a]TPPI & STAM scale: 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist. [b]Did participant rate self as confident in ability to mentor protégé with inquiry-based instruction?

increased and her understanding of scientific inquiry increased. Her perceived efficacy toward mentoring other colleagues to use inquiry-based instruction increased after course participation as well.

Case Study T3 - Daphne

I. Basic Demographic Information

Daphne, a non-Hispanic White female, was a novice teacher in her 6th year of teaching during the 2002-2003 school year. Daphne taught a self-contained fourth grade class within an inner-city, elementary magnet school which was also a *Project Grad* school. During the 2002-2003 school year she taught a magnet class and during the 2003-2004 school year she taught a non-magnet class. Her non-teaching assignments included tutoring (math), bus duty, technology mentoring, and designation as a supervisor of Move-It-Math^{TM} (Project Grad). She indicated spending 1 hour per week for science preparation prior to the PI course and 2 hours per week after participation.

Prior to participation in the PI course, Daphne was not a member of, had not attended, and had not presented at local, state, regional, or national science teacher conferences. She had received Urban IMPACT's mentor training and was a member of her school's mentor core team. After completing PI, she became a member of the Tennessee Science Teachers' Association (TSTA) and presented information regarding the PI course at two conferences: TSTA and the international conference for the Association for the Education of Teachers of Science (AETS).

Daphne's school serves Kindergarten-5th grade students, of which 90.7% are economically disadvantaged. The demographics of the student body are 18.9% White, 78.8% African American, 2.0% Hispanic, 0.1% Asian, and 0.1% Native American. The

demographics of the two classes that were observed for the pre- and post- observations are described in Table 21. She had a total of 14 students in each of the pre- and post observations.

II. Research Question One Analysis

"Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

STAM analysis.

Daphne's STAM Video Portfolio for pre and post observations can be found in Figure 14. The Video Portfolio provides an overview of the participant's instruction as well as a description of the teaching style observed for each of the 22 teaching aspects of the STAM. Daphne's summary STAM scores for pre and post observations are located in Table 22 and her numerical averages for the five categories of the STAM matrix are located in Figure 15 (see Appendix K.1 for summary STAM scores and K.2 for average calculations). Chapter III, Stages of STAM analysis describes the method (see Appendix D.1 for Standard Operating Procedures, D.2 for Analysis Matrix, D.3 for Video Portfolio template, and Appendix J for Pre and Post STAM Records of Activities for each participant).

Table 21. Daphne's Class Demographics Pre- and Post- Observations (T3).

	Males		Females	
	Pre	Post	Pre	Post
African American	6	9	2	5
White	4		2	
Totals	10	9	4	5

STAM Pre-Observations
OVERVIEW: The focus of these lessons was on plastics and polymers. Day one included a discussion of plastic and introduction to vocabulary; reading a one-page handout regarding plastics individually or as part of a group; an introduction to a 3-day experiment of measuring plastic animals (*Jungle Friends*™) that grow when placed in water; and completion of a written reflection of what they have learned and what they would like to learn more about. Day two included a review of vocabulary and reflections; reading an article from a *National Geographic* student magazine on how gum is produced from tree sap (individually or with a partner); and each student wrote four questions and answers from the reading that could be selected for use on a test. Day three included a vocabulary review; measurement and discussion of plastic animal growth; and a webquest regarding polymers. The teaching is best described as transitional to conceptual. Didactic - 3; Transitional - 7.5; Conceptual - 11.5[a]
CONTENT: 1B[b]. Content tends to be descriptive with concepts and factoids given equal emphasis. 2C. Examples and connections made by teacher to real world events, related ideas, and key ideas of plastics. 3A. The content is over-simplified so that the limits or exceptions within content are not presented. Many statements are absolutes without qualifiers. 4C. "How we know" included in content. Teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5C. Rich repertoire of teacher-centered methods, including hands-on. 6B, 6C. Some demonstrations and hands-on activities which are overly directed and some which are conceptually focused. Answers generally known ahead of time. 7C. Teacher-student interaction about correctness of students' knowledge of conceptual content. 8B. Teacher's questions directed toward scientific ideas, not toward connections or applications. They do not build on students' responses. 9C. Assessment is used for frequent checking, in addition to tests & quizzes, of students' knowledge. 10B. Assessment is used for checking students' knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12C. Several forms of writing and other representation of ideas are used including reflections, writing four test questions, data collection, and completion of a webquest. Most are reconfigurations of information provided. 13B. Student questions clarifying procedures dominate. Some questions ask for clarification of terminology or repeat of information. 14B. Some student-student interaction, mostly about procedure. 15C. Students volunteer examples related to class activities. 16C. Students accept procedures and role.
RESOURCES: 17C. Multiple resources including *Jungle Friends*™, rulers, scale, *National Geographic* magazines, handouts, and demonstration materials are used. 18C. Resources are related to content and illustrate ideas. 19B. Access to resources is controlled by teacher.
ENVIRONMENT: 20A. The environment is teacher-dominated. 21B. Some teaching aids displayed, but may not be related to content. 22A. Few examples of students' work displayed.
OTHER: Desks are arranged in groups of four to assist with group activities. Day three of the pre-observation was videotaped for the researcher; however, the tape was misplaced before viewing. Therefore the teacher wrote a synopsis of the activities for the researcher.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 14. Summary of Video Portfolio - Daphne (T3).

STAM Post-Observations
OVERVIEW: The focus of this lesson was on planning an investigation with mealworms. Day one included completion of the K & W of a KWL chart (what students know and what they want to find out) about bugs (not told they were mealworms); observation and discussion of bugs; designing an experiment regarding the bugs as a class; and reading individually from various trade books about insects. Day two included a detailed planning of the experiment with teacher and student input; conducting the experiment; and discussion of appropriate teamwork and experiment results. Day three included a review of what students had learned about the bugs; an introduction to the bugs as mealworms (teacher read a book to them); completion and discussion of a teacher-created webquest regarding mealworms; and an opportunity for students to describe another experiment that they would like to conduct with mealworms. The teaching is best described as conceptual to early constructivist. Didactic - 1; Transitional - 1; Conceptual - 9; Early Constructivist - 10; Experienced Constructivist - 1[a]
CONTENT: 1C, 1D[b]. Teacher and students mostly negotiate understanding of key ideas with teachers' content emphasized. There were several instances in which the content tended to be explanatory with conceptual content organized around key ideas. 2C, 2D. During day one and two the teacher primarily leads students in using examples and constructing connections to real world events, related ideas, and key ideas of concept. On day three, examples and connections were made by teacher. 3C, 3D. Limits, exceptions, and alternate interpretations are presented as part of the content for the majority. In several instances, the teacher leads students to identify limits and exceptions that may generate alternate ways of representing or interpreting observations and events. 4C, 4D. During day one and two, the teacher leads students to reconstruct how evidence has been used to formulate scientific ideas and to use scientific processes to formulate and evaluate ideas. On day three, the teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5D. Some use of student-centered methods such as group work, student writing (journal), and discussions. 6D. Investigations and hands-on activities lead by teacher and incorporate some students' ideas. 7C, 7D. During day one and day two, teacher-student interaction mostly about clarification and usefulness of students' ideas and understanding is teacher-directed. On day three, interaction is about correctness of students' knowledge of conceptual content. 8C, 8D. During day one and day two, teacher's questions are goal-oriented and occasionally emerge from students' responses. They are used to clarify students' ideas. On day three, teacher questions are directed toward knowledge of scientific concepts and their connections and applications and do not build on students' responses. 9D. Assessment in multiple forms. Some assess students' knowledge and some assess students' understanding. 10C. Assessment is used for checking students' knowledge and preplanning. 11C, 11D. During day one and day two, the teacher occasionally seeks student' ideas and considers them in instructional decision-making, using this information some of the time in designing activities. On day three, the teacher investigates students' ideas about subject matter and works to alter unscientific ideas.
STUDENT'S ACTIONS: 12D, 12E. Students occasionally use writing and other representations of ideas as part of developing their understanding and constructing meaning. Some is reconfiguring information provided. 13C. Student questions focus on clarification of meaning related to specific concepts or procedure. 14C, 14D. Some student-student interaction directed toward understanding and applying scientific ideas and some about procedure. 15C, 15D. Students volunteer analysis as well as examples. Some are related to class activities and others are weakly related. 16C, 16E. Students accept procedures and role. During the experiments, students do some negotiation with teacher.
RESOURCES: 17D. Multiple resources including mealworms, magnifying glasses, trade books, computers, and mealworm experiment supplies (container and food choices) are used. 18D. Some resources are used to aid students' understanding and application of ideas. 19C. Access to resources controlled by teacher, but there is some discussion of access with students.
ENVIRONMENT: 20C. The environment is teacher-controlled and there is some sharing of decision-making with students about use of time. 21B. Some teaching aids displayed, but may not be related to content. 22A. Few examples of students' work displayed.
OTHER: Desks are arranged in groups of four to assist with group activities. Observations of mealworms were conducted on the floor.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 14. Continued.

Table 22. STAM Summary Scores - Daphne (T3).

	1A Didactic	2B Transitional	3C Conceptual	4D Early Constructivist	5E Experienced Constructivist
Content - C; Rows 1-4 Summary: Pre= 2/3 Post= 3/4					
1		▣	●	●	
2			▣ ●	●	
3	▣		●	●	
4			▣ ●	●	
Teacher's Actions - TA: Rows 5-12 Summary: Pre=2/3 Post=3/4					
5			▣	●	
6		▣	▣	●	
7			▣ ●	●	
8		▣	●	●	
9			▣	●	
10		▣	●		
11			▣ ●	●	
Student's Actions - SA; Rows 12-16 Summary: Pre=2/3 Post= 3/4					
12			▣	●	●
13		▣	●		
14		▣	●	●	
15			▣ ●	●	
16			▣ ●		●
Resources - R; Rows 17-19 Summary: Pre=2/3 Post= 3/4					
17			▣	●	
18			▣	●	
19		▣	●		
Environment - E; Rows 20-22 Summary: Pre= 1/2 Post=2					
20	▣		●		
21		▣ ●			
22	▣ ●				
Total STAM Summary: ▣ Pre-Observations = 2.4 ● Post-Observations = 3.4					

Notes: Summary values written with slash indicate score wobbles within range. Teaching styles (A-E) were coded with numbers (1-5) for the purpose of calculating a numerical average displayed in Figure 15.

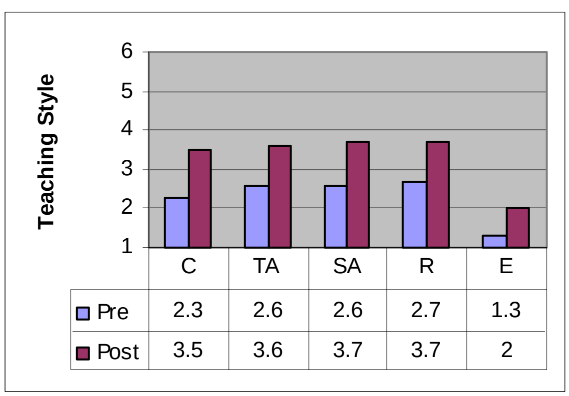


Figure 15. Daphne's Summary STAM Scores.

Interview analysis.

Interview analysis for Research Question one includes the analysis of the seven questions listed in Table 4 for Teacher Actions. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher Actions can be located in Appendix C.4.

Daphne expressed a slightly more teacher-centered than student-centered Teacher Action (TA) style before and after the PI course. Daphne felt constrained by working at a target school for improving math and reading test scores and hence felt impelled to teach "to the test." She didn't feel encouraged to teach science because the administration asked the teachers within the school to focus on planning for and teaching reading and math. Before taking the PI course she wouldn't have been disturbed by this; however, she stated, "now that I see the importance of science through this class it upsets me that I don't get the support to teach science and I don't get the time to plan science." Although preparation for standardized testing was the emphasis within her class she incorporated student ideas and tried to make lessons meaningful through group activities. She moved from concept to concept by assessing projects and tests and by using observations of student understanding.

She expressed a concern for mutual respect among students in order for hands-on, group activities to be productive. She stated the importance of establishing classroom management skills and teaching the students how to work as a team. Daphne credited a workshop conducted by Max Thompson as helpful by giving her many ideas for teaching using graphic organizers and cooperative learning activities.

Daphne's response to student diversity was conceptual. She used peer tutoring, interactive software, and internet websites for all students and she rarely used textbooks. She made sure that she provided special projects for the TAG (Talented and Gifted) students and brought in extra books and websites for them to explore. The group of students that she had during the post-interview (non-magnet class) had less parental support than her previous class (magnet). She found that many of her non-magnet students came from homes in which parents were uneducated, with few books in the home. She, along with her grade level team of teachers, planned field trips to provide opportunities that the students were not experiencing at home such as visiting the zoo. Daphne's pre- and post averages for Teacher Action style wobbled between transitional and conceptual at 2.7 and 2.8 respectively. Teacher Action excerpts are located in Table 23.

SIDESTEP analysis.

Daphne stated that she used required *Project Grad* strategies to address gender equity issues (such as the "go-around" cup in which she draws a name out of a cup for questioning). She did not use a textbook for science instruction. Daphne reported the use of group work, worksheets, discussions, standardized tests, projects, quizzes, and computers to assess students' understanding of science prior to and at the completion of the PI course. She incorporated portfolios, homework, and concept maps after PI participation. Her top three goals for students' learning in science included: the student will be able to conduct an experiment and gather data; the student will engage in critical thinking skills; and the student will have the desire to probe and find information and seek explanations.

Table 23. TPPI Interview Codes and Transcript Statements for Daphne (T3) Pre and Post - Question One.

	Three categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
A	Pre: "I hate teaching to the test, but I'm in a school that's on the list and they are not asking you to do anything that's not on the test." (18) *Post: "As a fourth grade team we do a lot of planning together to make sure each one of those objectives is met before the Terra Nova. The school year ends in March as far as we are concerned." (18)* Pre: "You have to establish classroom management." (24)	Pre: "The different kind of things we do for classroom management - I'm not real fond of it. We have to do them and somebody comes and checks us off. I think it's great for first year teachers who have to learn all of the curriculum, the daily procedures, plus deal with classroom management." (25) Pre: "I think the reason why I haven't become such a good science teacher is because they'll (administration) flat out tell you, don't teach social studies and science, focus on reading and math." (25) *Post: "Being a school that is a target school, since last year they have placed more programs in our school. So teachers have less say in what they get to teach and I think that burdens the teacher's creativity and love for teaching. We have a math program this year which I think eventually is going to be good but I don't think they give us enough time to plan and we've only had one week in training and then we are supposed to go save our scores? And then we have a new reading program which they don't give us the money to buy the materials to make it effective in our room. It upsets me because if you are spending all your time planning for the new math and reading program you don't have anything left for the other subjects which before I would have thought, 'well I don't care anyway', but now that I see the importance of science through this class, it upsets me that I don't get the support to teach science and I don't get the time to plan science. We get thirty minutes a day and that's wedding the time of teaching with social studies." (25)*	

Table 23. Continued.

	Three categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
B	Pre: "Even though the test is the emphasis, I get the kids input and try to turn it around to where I'm excited about it. I usually think, 'Ok, here's the objective, I've gotta teach it, how can I make this lesson awesome, how can I get them involved, and how can I include technology'." (18) Pre: "I move from concept to concept just by assessing. It could either be projects or tests, or just observations."(19) Pre: "I change the way I group the kids." (33)		
C	*Post: "Through workshops this summer and learning more about what I need to do in the classroom, like setting up my lesson plans, I've added ___ standards and state standards to my planning." (18)* *Post: "I change the bulletin boards to whatever we are learning (in reading). So at all times if they need reinforcement while they are doing practice work, it's somewhere in the room to help them out without actually having to ask me." (33)*	Pre: "I went to a workshop last year and got tons of ideas to implement in the classroom, like the K-W-L charts, the 3-2-1, the jigsaw, and other graphic organizers. There's a huge notebook and if I need a new idea, or if I'm like how am I going to get this across, I just look through that notebook and I find tons of stuff." (25)	Pre: "I use peer tutoring. I have some software that is visual and they can listen to it instead of having to read it. A lot of websites will help out because they will read what you need to know. I rarely ever use textbooks. I have a lot of parental support and when I have kids that have special needs, I can usually get them in here to help me." (38) *Post: "I have two TAG students in my class and to accommodate their needs, I've given them special projects to do. I always make sure whatever we are studying at the time that there's always books, websites to look at." (38)*

Table 23. Continued.

	Three categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
C			*Post: "There's actually something on the IEP now, about how their environment at home affects their learning. There are kids in my class that come from homes where parents are not educated, there are not many books in the house, they don't get any kind of parental support when it comes to education. So I feel like I need to accommodate these students with giving them more opportunities. For example, field trips, like things you usually think parents are going to do. We taught an animal unit last six weeks and it's amazing how many of my kids have not even been to the zoo. So as a grade level, we've actually talked about more field trips when it comes to science and social studies or having people coming in to speak and giving them things that they should be getting at home.." (38)*
D	Pre: "You have to have classroom management and the kids have to have respect for each other. If they don't it's very hard and they have to learn to work as a group." (23) Pre: "I have to teach them pretty much self skills and how to work as a team and usually by, you know, Christmas they're OK. When you are making plans and you want the kids to do hands-on activities together in group work, you've got to make sure you've got that established first because you can't get anything done if they are fighting and disrespecting each other." (24)	Pre: "The Terra Nova (standardized test) makes an impact."(25)	
E	Pre: "I pick what I need to teach from the test and then I take my own stuff and add it to the pot, and then I take the kids' input and just kind of mix it all together to get a lesson out of it." (18)		

Note: #33 not answered in pre-interview

Summary of Daphne's results for research question one.

STAM analysis revealed that Daphne exhibited primarily transitional to conceptual teaching behaviors during pre observations with a total STAM summary average of 2.4. During post-observations she primarily exhibited a conceptual to early constructivist teaching style with a total STAM summary average of 3.4. Her pre summary STAM averages: increased from an average between transitional and conceptual to an average between conceptual and early constructivist for four of the five classroom aspects measured (Content, Teacher Actions, Student Actions, and Resources); and increased from a didactic/transitional average (1.3) to a transitional average (2.0) for Environment.

Analysis of Daphne's TPPI interview questions (beliefs) revealed that her pre and post average for Teacher Actions (TA) showed negligible difference (from 2.7 to 2.8 - transitional/conceptual). These averages, close to conceptual, revealed that her TA beliefs were similar to her behaviors but not quite as constructivist. Her post-STAM TA average (behaviors) was 3.6 which wobbles between conceptual and early constructivist.

III. Research Question Two Analysis

> "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

Interview analysis.

Interview analysis for Research Question two includes the analysis of the ten questions listed in Table 4 for Student Actions and Teacher's Philosophy of Teaching. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average

calculations for Student Actions and Teacher's Philosophy of Teaching can be located in Appendix C.4.

Daphne expressed primarily conceptual to student-centered styles for Student Actions (SA) prior to and at the completion of the PI course. Daphne's pre- and post averages for SA wobbled between conceptual and early constructivist styles with an average of 3.5. She felt that each student was a different kind of learner and that it's up to the teacher to use a variety of styles to meet all children's needs. She knew students understood concepts by using group discussions, giving short quizzes, and through teacher observations. She believed that students valued their experiences in her classroom because she made it fun and she tried to boost their self-esteem. Daphne described how she did not have to show students within her magnet class (pre-observations), how to work in groups because these students had previous experience in magnet classes in which they were shown how to work in groups. However, her non-magnet class (post-observations) needed assistance learning how to work with each other. SA excerpts for Daphne are located in Table 24.

Daphne's Philosophy of Teaching was primarily student-centered. She described herself as a hands-on kind of teacher who rarely used textbooks. She viewed good learners as hard-working and dedicated. Daphne felt that students needed to learn the value of the social and life skills that she taught in her classroom. "They need those skills so that later down the road when they do start working in the real world they will know how to work with others." She allowed students to discuss the importance of what they were doing in the classroom and how they could use the knowledge outside of the classroom. She felt that teaching was part of a life-long learning process and that her

Table 24. TPPI Interview Codes and Transcript Statements for Daphne (T3) Pre and Post - Question Two.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
A				Pre: "I could always use improvement in classroom management. The two subjects I'd really like to focus on are reading and science." (40) *Post: "I feel like I still need to improve in science, but through this class, I've got a better understanding of how to teach it and how to teach the concepts better." (40)*
B	Pre: "A lot of the time we have group discussions or I can give a short quiz." (30)			
C	Pre: "I know they understand if they can engage actively and give input and answer the questions They just did a Power Point project on animals and I could tell how much they learned on their research by how much they put in their power point." (30)		Pre: "I mean like everything they learn they are going to have to use it sometime down the road for life skills. Everything they need in this room, they need to have for the next step." (20) *Post: "I'm sticking to the life skills answer. Everything that they learn in the room, I feel like they need to be able to use it in their everyday life." (20)*	

Table 24. Continued.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
D	Pre: "I think every teacher has to realize that each student is a different kind of learner. Um, you can't just teach one way every single time and you, for me, it's been wonderful, I only have 14 kids and I can tell you how each kid learns. And it is my responsibility to make sure that I make the lesson or whatever they are doing, or some way to bring things to where I know they can learn." (29)	Pre: "I think students like this class because it's fun. I let them know during the year that they're smart and if they put their mind to it and they work hard, they can learn and do anything. I really try to help with self-esteem because I think if a kid feels good about themselves they will put more into their education." (37)	Pre: "I'm more of a hands-on kind of teacher. I like the kids to get involved and I rarely ever use textbooks. The kids help me design lessons, they have input in what I do in the classroom." (1) Pre: "A good learner is hard-working and dedicated. I tell the kids, you might not grasp the concept the first time, you know, you might feel frustrated, you might get all upset, but if you just keep trying that's all I need from you." (13) *Post: "I also want to add that they need to know the value of working with others and working in groups and having the social skills they need. They need those skills so that later down the road when they do start working in the real world they will know how to work with others." (20)* Pre: "I think teaching is a profession of learning all the time. I mean it's going out there and talking, and learning, and watching, and reading about new stuff." (21) Pre: "We do a lot of group work in my classroom. I always let the kids tell me what they've seen and what they've done, you know, so they're always talking and trying to relate, 'how would it relate to us?' life-skills wise." (22)	Pre: "The kids know that I love my job and that I respect them, and I think that makes them feel comfortable in my room. I'm hard-working and I think they see that and they want to work hard for me. I love to teach and my attitude is reflected in the classroom." (39) *Post: "I think this is the first year that I feel like a seasoned teacher. Just by listening to other teachers and seeing where they are at in classes, I've been able to give more advice. I am more of a mentor now than I am a novice." (39)*

main strength as a teacher was that she loved her job, which was reflected through her hard work in the classroom. In turn her students tried to work hard for her. She always felt that there was room for improvement in classroom management. She wanted to improve her ability to teach reading and science. Daphne's pre- and post-averages for PT wobbled between conceptual and early constructivist with averages of 3.4 and 3.5 respectively. PT excerpts for Daphne are located in Table 24.

Constructivist Learning Environment Survey - CLES analysis.

Daphne's CLES scores are exhibited in Figure 16. Her pre (25) and post (24) Personal Relevance scores were in the high intermediate agreement range, indicating that she often but not always emphasized linking school science with students' everyday experiences (see Appendix F.3 for calculations). Her pre (22) and post (22) Critical Voice scores were both in the high intermediate agreement range as well and indicated that students sometimes but not always were encouraged to question Daphne's plans and methods and express concerns about impediments to their learning. Her pre (22) and post (19) Shared Control scores decreased from a high to low intermediate agreement range after participation in the PI course. This indicated that Daphne did not feel as comfortable inviting students to: participate in designing their own learning activities; determine assessment criteria; and negotiate the norms of the classroom. Her pre (25) and post (22) Student Negotiation Scale scores which were in the high intermediate agreement range and indicated that she often but not always provided opportunities for students to: explain their ideas to other students; make sense of other students' ideas; and reflect on the viability of their own ideas. Her pre (24) and post (29) Attitude Scale scores increased from a high intermediate to a high agreement range. This indicated that

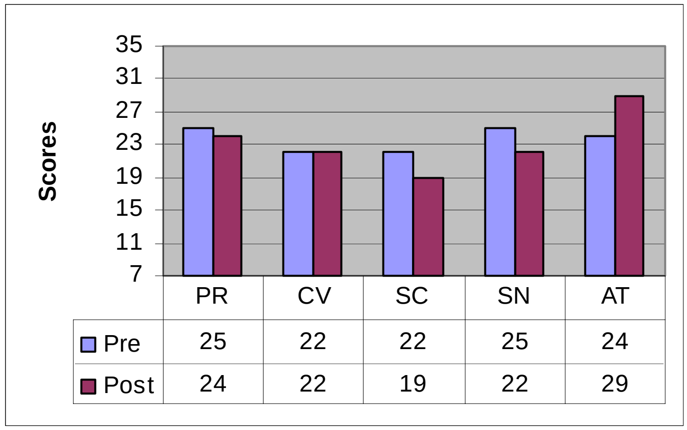


Figure 16. Daphne's CLES Scores.

after participation in the PI course she felt that students more often: anticipated the activities within her classroom; found the activities worthwhile; and understood and enjoyed the activities.

Science Teaching Efficacy Belief Instrument - STEBI analysis.

Daphne's Personal Science Teaching Efficacy Belief subscale scores for the pre and post assessments improved notably from a low to an average efficacy, with 28 points and 41 points respectively (max=65 points). Therefore, after participation in the PI course, she was more comfortable with her ability to teach science. However, her Outcome Expectancy (OE) subscale scores for the pre and post assessments decreased notably from 47 (high OE) to 43 (average OE) points (max=60 points), indicating she had a decrease in her confidence in her teaching ability to create desirable outcomes (see Appendix G.2 for calculations).

Reflective journal questions.

Daphne described a positive attitude toward the PI course and expressed expectations to be able to improve her science teaching (Excerpt A). She felt that group discussions as part of the course assisted her professional growth as a science teacher (Excerpt B). She also expressed a constraint to planning for science when she was responsible for planning for a new reading and math program (Excerpt C).

Excerpt A (4/25/03) "My personal outcome for this course is to become a more effective science teacher. I would like this class to give me a better understanding of how to implement the inquiry- based approach into my science lessons. I would also like to become more proficient in designing science lessons that include research, enhancing critical thinking skills, and hands-on activities. I now feel like this course will help me meet my objectives."

Excerpt B (5/27/03) "I think class went great last time we met. The discussion was the best part. I always learn a lot when I hear other teacher's views and experiences. It also gave me an opportunity to get to know the other teachers a little better."

Excerpt C (9/23/03) "I have been overwhelmed with the beginning of school and planning my science lessons. Now that we have started a new math and reading program, science has been hard to work into my hectic schedule. We are doing animals this six weeks so I am excited about introducing my mealworms to the class. I think I will do the lessons from the book I got from you. The kids will love it.

Summary of Daphne's results for research question two.

TPPI analysis of Daphne's pre and post Student Actions (SA) and Philosophy of Teaching revealed that she held beliefs that wobbled between conceptual and early constructivist. Her behaviors for SA as described in Section II became congruent with her beliefs after PI participation with a post-STAM SA average of 3.7 (conceptual/early constructivist).

Daphne's CLES scores for the Personal Relevance and Critical Voice subscales were in the intermediate agreement range. Her interview responses which correlated with these subscales revealed that she felt teaching students life skills and meeting their individual needs by incorporating lessons that were personally relevant were important to her students' success. Her Shared Control and Student Negotiation subscale averages decreased slightly from pre to post observations. Daphne switched from a magnet class to a non-magnet class which she did not feel was as prepared emotionally or behaviorally to handle the responsibility of group work or student-centered activity. Her Attitude subscale scores increased from 24 to 29 (high intermediate to high agreement). Her interview responses indicated that she felt students enjoyed her class because "it's fun" and she boosted their self-esteem by helping them realize they can do the work.

Daphne became confident in her ability to teach science after PI participation as revealed by her STEBI, Personal Science Teaching Efficacy Belief Scale scores. Her beliefs to create desirable outcomes pre and post were confident but not highly confident as measured by the STEBI, Outcome Expectancy Scale scores. According to Daphne's journal responses, her personal goal for the PI course was to help improve her confidence and pedagogical skills in teaching science.

IV. Research Question Three Analysis

"Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

Interview analysis.

Interview analysis for Research Question three includes the analysis of the three questions listed in Table 4 for Teacher and Content. Chapter III, levels of TPPI analysis

describes the process of analysis. Numerical average calculations for Teacher and Content can be located in Appendix C.4. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Daphne expressed primarily a teacher-centered style for Teacher and Content (TC) prior to and at the completion of the PI course. Prior to the PI course, she stated that she did not like teaching science because she didn't have enough resources and she found the textbook boring. After the course, she stated, "science is finding out and pursuing knowledge about the natural world." She valued science because it is something that can get kids excited through observation, exploration, and questioning. She believed that students can learn to respect each other through learning to respect the earth. She credited the PI course (her one student-centered statement) with helping her learn how to incorporate inquiry into all of the subjects she teaches, "I want my students to learn how to think, ask questions, explore, and observe." Daphne's pre TC average of 2.0 was transitional; while her post-average of 2.3 wobbled between transitional and conceptual. Daphne's TC excerpts can be located in Table 25.

When asked to define scientific inquiry, Daphne had a limited response and was not confident about her definition prior to the PI course. However, after the course she was confident in her response and described inquiry as open/full inquiry.

3/14/03 (Pre-interview) "Just finding out information about new things. I don't know."

Table 25. TPPI Interview Codes and Transcript Statements for Daphne (T3) Pre and Post - Question Three.

Style	Teacher and Content (14, 28, 34)
A	Pre: "I honestly don't like teaching science and I don't think they actually give you the resources. The textbook doesn't really get the students involved in science, I find it boring. Science at the 4th grade is about the earth and recycling. There's a lot of things I'd like to do in science that they just don't fund so I can't really get the kids involved." (14) *Post: "Science is finding out and pursuing knowledge about the natural world. A year from now I would probably have a different answer." (14)*
B	Pre: "I think science is like an ongoing thing, there's always things to find out. It's more … experimenting, finding it out on your own with experiments and reading. it's never-ending and the kids see that also. My kids get excited when you have a hypothesis and you don't know, you know they really grasp that and are like what's really going to happen." (28) *Post: "The reason I find it valuable is because there is always something that can be observed, explored, or questioned, which makes it quite interesting." (28)*
C	Pre: "The unit that I have focused on this year is recycling and the environment. For some reason, I guess it's because I got motivated, all the kids were motivated, so the next thing you know we are composting down in the cafeteria once a week. We have a contest and we are second place in the whole school. Kids are collecting newspapers this year, they collect cans and plastic bottles. And just from me being excited, it has just really taken off and now they are doing it on their own. It's kind of like a character thing of how we respect ourselves and how we respect others and it came to respecting the earth." (34)
D	*Post: "One thing I learned in this class is how to add inquiry into my science lessons. I want my students to learn how to think, ask questions, explore, observe, not in that order but do all of this process to get at an answer through themselves, not just me telling them. And using that not just in science, but in any subject in school." (34)*

11/13/03 (Post-interview) "Scientific inquiry is a way of finding out new information through questioning, observing, exploring, experimenting, and evaluating certain concepts and figuring out if it's true or not. I don't think it's necessarily the truth every time, but finding out if your hypothesis is correct or not."

When asked to describe if she had ever experienced learning by inquiry, Daphne described a negative response toward science experiences in general before the PI course. During her post-interview, she described her experiences learning by inquiry in the PI course, how she transferred the learning to her own science teaching, and transferred the use of inquiry to other school subjects.

3/14/03 (Pre-interview) "I got little information about ways in science. I mean in high school, I took chemistry and then in college they only required you to take biology which was in my freshman year and then you had one methods class and then that was it. I mean I haven't had any really positive experiences with science and that's probably the reason why my scores are so low because I just haven't had the information. Um, I haven't really had the science experiences to prove to be a good science teacher. You know, everything I know, is from back in '92 when I was in college. I'm embarrassed of how little science I've had."

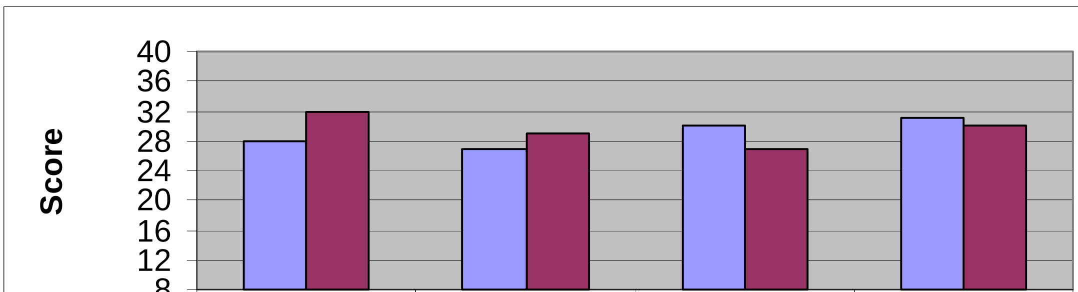
11/13/03 (Post-interview) "Well I have three things to say. The first thing is since the first interview I've had the chance to experience learning by inquiry in the class with the plants. Actually being the student and going through the process of learning and um setting up, well actually observing and setting up an experiment and finding out information. My students were able to do a unit on mealworms as part of their six weeks on animals and they were able to do a 5E lesson plan and they were able to engage in the inquiry process. I've used it this year in other subjects, especially in math. I don't just tell them the answer or how to get the answer, I let them think about it, work with manipulatives, figure it out themselves and ask questions and why does this happen before I just go ahead and teach it. I give them a chance to explore. So that's the third way that I've been able to add that into my classroom."

Daphne described her experiences teaching with inquiry after PI participation as positive. Her first inquiry-based science lesson was guided and allowed students to design an experiment using mealworms. She cited time limits for planning and lack of resources as constraints to using inquiry-based lessons more often.

10/12/03 "I was fortunate to be able to teach a few lessons using the mealworms. The kids were very excited about experimenting with the mealworms. They loved taking observations and notes on the mealworms. The class chose to do an experiment on what mealworms like to eat. Then they got to do a little research about the mealworms on the internet. This week they will create a concept map about mealworms and a *PowerPoint* presentation. They really enjoyed the past week in science. As the teacher I thought this was a great week in science too. I enjoyed trying something new and the kids loved doing it. The only sad part is I don't have enough time to do this every week. I wish I had more materials and time to plan for science. Hopefully I will start making time to plan and allocate more time for science in the classroom."

Modified Nature of Scientific Knowledge Scale - MNSKS analysis.

Daphne's MNSKS subscale scores, Figure 17, were within the accepted view range of the Nature of Science (above 24). The scores were not noticeably different for the pre and post assessments with the exception of the Creative subscale in which there was a four-point increase. Daphne's Total MNSKS Scale Scores were toward the accepted view of the NOS (above 96) and her pre and post assessment scores of 116 and 118 respectively were not notably different (see Appendix H.2 for calculations)



	Creative	Developmental	Testable	Unified
Pre	28	27	30	31
Post	32	29	27	30

Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 17. Daphne's MNSKS Scores.

Constructivist Learning Environment Survey - CLES analysis.

Daphne's pre (20) and post (14) Scientific Uncertainty scale scores were in the range of "seldom to sometimes." This indicated that Daphne did not provide many opportunities for students to learn that scientific knowledge is: evolving and provisional; shaped by social and cultural influences; and arises from human interests and values.

Reflective journal questions.

Daphne reflected in one journal response about the nature of scientific research in response to the class science journal presentations. She expressed that she had not realized the range of scientific research.

5/9/03 "I thought the presentations were awesome. I really enjoyed that article about the cows. I am a big animal lover and that was very interesting. I never knew scientists would ever think about doing experiments on some of those topics. My article was very informative. I learned more about the topic of Sickle Cell Disease and Zinc. I was glad I got a topic concerning children. At first, I was very frightened with the vocabulary and content. When I saw the data sheet on the research, I almost died. Then I realized I wasn't supposed to know everything about statistics. That is when I calmed down and gave it another shot. Finally, after my presentation was over I realized I learned a lot and really did enjoy studying the topic. Even though I enjoyed the other presentations I wish more topics were related to kids or education."

Summary of Daphne's results for research question three.

Analysis of Daphne's pre (2.0) and post (2.3) Teacher and Content beliefs revealed teacher-centered scores ranging between transitional and conceptual. Her MNSKS pre and post subscale scores did not change noticeably, with the exception of the creative scale which increased four points. All scale scores were toward the direction of the currently accepted view of the NOS. Her CLES Scientific Uncertainty score decreased from a score of 20 to 14 (possible range 7-35) indicating that she believed she provided fewer opportunities for students to view science as tentative. Although her

Developmental MNSKS scores (which measure the perception of the tentativeness of science) were toward the accepted view of the NOS they were not far from a neutral score. This could account for her low ranking of teaching this attribute to students in the CLES instrument. In responding to the science journal presentations, Daphne commented in her reflection that she did not realize the range of scientific research that was possible.

Daphne had little confidence in her definition of inquiry before PI participation; however, after the course she described inquiry as full/open inquiry as was used in the class. Prior to the PI course she had limited experiences with inquiry and negative experiences in general with science. She credited the PI course with giving her a positive experience with scientific inquiry and helping her to transfer the learning to her classroom teaching in science as well as other subjects.

V. Research Question Four Analysis

"Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

Mentoring Efficacy Questionnaire - MEQ analysis.

Daphne's pre MEQ score of 70 (out of 100) points increased to a post-score of 75 points, both of which were in the high intermediate mentoring efficacy range. She indicated that she strongly disagreed that she could help a protégé implement inquiry-based science instruction prior to the Project INQUIRE course (Question 20); however, after the course she indicated that she was confident in her ability to mentor protégé's in this type of instruction.

Prior to the PI course, Daphne indicated her greatest strength as her willingness to learn new things and to share with others, "I enjoy sharing my experiences with new teachers;" and her greatest challenge was that she did not feel comfortable teaching science in her class, "I think when I gain better understanding of this subject, I will be willing to help others." After taking the PI course, she indicated her greatest strength as patience and willingness to help in any way. Her challenge was, "I haven't taught inquiry-based lessons before this class, so I feel like I am still a learner. However, I do have a better understanding on how to design and teach an inquiry-based science unit."

Reflective journal questions.

Daphne wrote several journal entries about sharing her learning and some of the activities that were conducted in the PI course with the teachers at her school (Excerpt A and B). She felt that the high emphasis on reading and math and the lack of materials were constraints to encouraging other teachers to use inquiry-based instruction; however, she felt if they were given opportunities to learn using inquiry-based method, as she was, they would understand it better and attempt to use it (Excerpt B).

Excerpt A (4/25/03) "The first class meeting was very productive, I now have a better understanding of how to define inquiry and problem solving. I thought the activity we did was great on how to differentiate between the two. I am anxious to use this activity with my grade level when we begin planning science for next year."

Excerpt B (10/12/03) "I bet explaining the inquiry process to the teachers at my school would be something new and exciting for them. However, my school does not put much emphasis on teaching science. My principal does think it is important, but Reading and Math are the subjects that we are supposed to concentrate on. I think I would have to let teachers be a part of an inquiry-based science lesson for them to grasp the concept. I think then they would realize how much more the students would gain from this way of learning. Many teachers would definitely try teaching science this way if they had the opportunity. However, I think my school would need more money and planning time to actually give the students a successful science program."

Summary of Daphne's results for question four.

Daphne's pre and post Mentoring Efficacy Questionnaire results indicated that she was confident mentoring other teachers (within the high intermediate efficacy range). She strongly disagreed that she was capable of mentoring teachers to use inquiry-based practices prior to PI participation; however, she expressed comfort after taking the course. Daphne expressed a desire to share learning from the PI course with teachers at her school. However, she cited lack of equipment, lack of planning time, and the high emphasis on teaching math and reading as constraints to teaching science in general. She described her post-observation year as the first year that she felt like a seasoned teacher and mentor rather than a novice teacher.

VI. Participant Summary

Table 26 is a data matrix for Daphne that provides an overall picture of her results for the Project INQUIRE assessments. Daphne's behaviors became more student-centered and constructivist after PI participation according to the STAM analysis. Her beliefs as measured by the TPPI Student Actions and Philosophy of Teaching and the CLES (PR, CV, and AT subscales) were congruent with her behaviors. Her perceived efficacy in teaching science improved as measured by the STEBI, interview responses, and journal reflections. The TPPI instrument analysis for Teacher Actions and Teacher and Content revealed beliefs that were closer to a conceptual style. Her STEBI, Outcome Expectancy scale scores and her CLES, Student Negotiation and Shared Control subscale scores decreased following PI participation corresponding to a change from teaching a magnet class to a non-magnet class. Daphne expressed negativity toward science and science teaching prior to PI participation; however, she expressed a desire to change this

Table 26. Project INQUIRE Data Matrix - Daphne (T3).

Teacher Information: Pre: 4th grade magnet; Post: 4th grade non-magnet; 6 years teaching experience

Question One: Do teachers who complete Project INQUIRE change their instructional practices?

STAM[a] Averages T=Teacher S=Student	Content		T. actions		S. actions		Resources		Environment	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
	2.3	3.5	2.6	3.6	2.6	3.7	2.7	3.7	1.3	2
Total STAM Summary	Pre: 2.4 close to Transitional					Post: 3.4 close to Conceptual				

TPPI[a] - Teacher Actions	Pre	Avg.: 2.7	Transitional/Conceptual
	Post	Avg.: 2.8	Transitional/Conceptual

Question Two: Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction?

TPPI[a] - Student Actions	Pre	Avg.: 3.5	Conceptual/Early Constructivist
	Post	Avg.: 3.5	Conceptual/Early Constructivist
TPPI[a] - Philosophy of Teaching	Pre	Avg.: 3.4	Conceptual/Early Constructivist
	Post	Avg.: 3.5	Conceptual/Early Constructivist
CLES -	Pre	Post	*<u>Scores</u>:*
Personal Relevance	25	24	*7-13 = Low*
Critical Voice	22	22	*14-20 = Low Intermediate*
Shared Control	22	19	*21-27 = High Intermediate*
Student Negotiation	25	22	*28-35 = High*
Attitude*	24	29	
STEBI -	Pre	Post	*<u>PE Scores</u>: 13-30 = Low; 31-48 = Average; 49-65 = High efficacy*
Personal efficacy-PE*	28	41	*<u>OE Scores</u>: 12-28 = Low; 29-44 = Average; 45-60 = High expectancy*
Outcome expectancy-OE*	47	43	

Questions Three: Do teachers who complete Project INQUIRE change their understanding of scientific literacy?

TPPI[a] - Teacher and Content	Pre	Avg.: 2.0	Transitional	
	Post	Avg.: 2.3	Transitional/Conceptual	
MNSKS:	Pre	Post	*<u>Scores</u>:*	
Creative*	28	32	*8-23 = Unaccepted view (32-95 - Total)*	
Developmental	27	29	*24 = Neutral view (96 - Total)*	
Testable	30	27	*25-40 = Accepted view (97-160 - Total)*	
Unified	31	30		
Total	116	118		
CLES - Scientific Uncertainty*	Pre: 20	Post: 14	*See Scale Scores in question two.*	
Inquiry - Definition and Experience	Definition Pre	Experience Pre (L) & (T)	Definition Post	Experience Post
Teaching (T) or Learning (L)	Limited	Limited	Open/Full inquiry	Guided (T) and Open (L)

Question Four: Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues?

Mentoring Efficacy	Pre	Post	*<u>Scores</u>:*
Total	70	75	*20-40 = Low; 41-60 = Low Intermediate;*
Question #20[b] *	Strongly Disagreed	Agreed	*61-80 = High Intermediate; 81-100 = High*

Note: *=notable change. [a]TPPI & STAM scale: 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist. [b]Did participant rate self as confident in ability to mentor protégé with inquiry-based instruction?

attitude. She credited the PI course with providing a positive experience with science and with changing her science teaching practices. She cited the lack of planning time, lack of equipment, and a higher emphasis on teaching math and reading as constraints to teaching inquiry-based science.

Daphne's knowledge of scientific literacy issues improved after PI participation. In particular, her knowledge regarding the definition of scientific inquiry was broadened. Her knowledge of NOS issues as measured by the MNSKS were toward the accepted view of NOS pre and post; however her views of science as tentative were not much above the neutral score (which is consistent with a low CLES, Scientific Uncertainty score). Her perceived efficacy toward mentoring other colleagues to use inquiry-based instruction increased after course participation. She also described herself as less of a novice teacher and more or a mentor teacher for the first time, during her post-interview.

Case Study T4 - Shannon

I. Basic Demographic Information

Shannon, a non-Hispanic White female, was a novice teacher in her 1st year of teaching during the 2002-2003 school year. Shannon taught all subjects with the exception of social studies to fifth grade students within an inner-city, elementary school which was also a *Project Grad* school. She had a unique situation in which she taught her students science for a six-week period and then traded them with another 5th grade teacher who taught them social studies for six weeks (one hour daily). In turn she taught science to the students who rotated to her classroom. Her non-teaching assignments

included participation on a faculty committee. She indicated spending one hour per week preparing for science prior to and at the completion of the PI course,

Shannon had attended a Mars, Space workshop at the University of Tennessee prior to participation in the PI course; however she had not made any conference presentations. She became a member of her school's mentor core team and received Urban IMPACT mentor training during the 2003-2004 school year. After completing the PI course she joined the Tennessee Science Teachers' Association (TSTA) and made a presentation regarding her experiences in the course at the state conference for TSTA.

Shannon's school serves Kindergarten-5th grade students, of which 75.0% are economically disadvantaged. The demographics of the student body are 73.0% White, 24.8% African American, 1.3% Hispanic, and 0.9% Asian. The demographics of the two classes that were observed for the pre- and post- observations are described in Table 27. She had a total of 20 students in each of the pre- and post observations.

II. Research Question One Analysis

> "Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

Table 27. Shannon's Class Demographics Pre- and Post- Observations (T4).

	Males		Females	
	Pre	Post	Pre	Post
African American	2	3	1	4
White	9	7	8	6
Totals	11	10	9	10

STAM analysis.

Shannon's STAM Video Portfolio for pre and post observations can be found in Figure 18. The Video Portfolio provides an overview of the participant's instruction as well as a description of the teaching style observed for each of the 22 teaching aspects of the STAM. Shannon's summary STAM scores for pre and post observations are located in Table 28 and her numerical averages for the five categories of the STAM matrix are located in Figure 19 (see Appendix K.1 for summary STAM scores and K.2 for average calculations). Chapter III, Stages of STAM analysis describes the method (see Appendix D.1 for Standard Operating Procedures, D.2 for Analysis Matrix, D.3 for Video Portfolio template, and Appendix J for Pre and Post STAM Records of Activities for each participant).

Interview analysis.

Interview analysis for Research Question one includes the analysis of the seven questions listed in Table 4 for Teacher Actions. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher Actions can be located in Appendix C.4.

Shannon expressed a more teacher-centered than student-centered Teacher Action (TA) style before and after the PI course. She used the curriculum to guide her instruction and felt there was not much time to fit in anything extra. As a first year teacher (during the pre-interview) she relied upon mentoring from other teachers within the school for ideas; however, she found it difficult to find time for discussion with other teachers (especially at her grade level). She preferred to use hands-on activities but felt

STAM Pre-Observations
OVERVIEW: The focus of these lessons was on the human body - bones, muscles, and senses. Day one included a review of bones - teacher asked students for common and scientific names of specific parts of the body; students read letters that they wrote to "The Body Corporation" that justified keeping a specific bone in the body; and an activity in which students practiced tiring their hand muscles. Day two included two teacher demonstrations pertaining to reaction time; the teacher read the textbook and asked the students to take notes on what was read; and students completed an assignment to list or draw a picture that described the steps of a stimulus. Day three included an extensive review of bones, joints, and reflexes in a teacher-led discussion and a teacher-led discussion regarding senses. The teaching is best described as transitional to conceptual. Didactic - 3; Transitional - 7; Conceptual - 11.5; Early Constructivist - .5[a]
CONTENT: 1C[b]. Content tends to be explanatory with conceptual content organized around key ideas. 2C. Examples and connections made by teacher to real world events, related ideas, and key ideas of the subject. 3B. Limits, exceptions, and alternate interpretations are presented as part of the content. 4B, 4C. In about half of the activities, there was no explicit mention of "how we know." Processes of science are not integrated with content. Whereas in the other half, "how we know" is included in content. Teacher integrates processes of science with concepts.
TEACHER'S ACTIONS: 5C. Rich repertoire of teacher-centered teaching methods, including hands-on. 6C. Many demonstrations or hands-on activities that are conceptually focused. "Answers" generally known ahead of time. 7C. Teacher-student interaction about correctness of students' knowledge of conceptual content. 8C. Teacher's questions are directed toward knowledge of scientific concepts and their connections and applications. They do not build on students' responses. 9C. Kinds of assessment include frequent checking, in addition to test & quizzes, of students' knowledge. 10B. Uses of assessment in addition to grading is for checking students' knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12C. Several forms of writing and other representations of ideas are used. Most are reconfigurations of information provided. 13A,13B. There are few student questions. Student questions clarifying procedures dominate and some ask for clarification of terminology or repeat of information. 14A,14B. Student-student interaction is rare and mostly about procedure. 15B, 15C. Students volunteer some examples related to class activities, connections to class activities may be weak. 16C. Students accept procedures and role.
RESOURCES: 17B. Text and a small number of resources, including some hands-on. 18C, 18D. Resources are related to content, illustrate ideas, and are used to aid students' understanding and application of ideas. 19B. Access to resources controlled by teacher.
ENVIRONMENT: 20A. Decision-making is teacher-dominated. 21B. Some teaching aids displayed, but may not be related to content. 22A. Few examples of students' work displayed.
OTHER: Classroom arrangement includes students seated in groups of four.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 18. Summary of Video Portfolio - Shannon (T4).

STAM Post-Observations
OVERVIEW: The focus of these lessons was light. Day one included a review of a spectrum sheet that was discussed during the previous class period; a discussion of reflection and refraction; and a student activity to determine the reflection and refraction of different types of mirrors followed by discussion. Day two included a review of the previous day's activities and a student activity mixing different colors of light followed by a discussion. Day three included a review of the previous days activities; a discussion regarding the reflection and absorption of light of objects led by the teacher (from textbook); and a student activity to explore the colors of objects in response to holding different colored cellophane over them followed by a discussion. The teaching is best described as conceptual to early constructivist. Transitional - 3; Conceptual - 9.5; Early Constructivist - 9.5[a]
CONTENT: 1C, 1D[b]. Content tends to be explanatory with conceptual content organized around key ideas. In a small number of instances, teacher and students negotiate understanding of key ideas with teacher's content emphasized. 2C. Examples and connections made by teacher to real world events, related ideas, and key ideas of the subject. 3C. Limits, exceptions, and alternate interpretations are presented as part of the content. 4C, 4D. "How we know" included in content. Teacher integrates processes of science with concepts. In several instances, teacher leads students to reconstruct how evidence has been used to formulate scientific ideas and to use scientific processes to formulate and evaluate ideas.
TEACHER'S ACTIONS: 5D. Some use of student-centered methods such as group work, student writing, and discussions. 6D. Investigations, demonstrations, and hands-on activities lead by teacher and incorporate some students' ideas. 7C. 7D. Teacher-student interaction is primarily about correctness of students' knowledge of conceptual content. Occasionally, interaction is for clarification and usefulness of students' ideas and understanding is teacher-directed. 8C, 8D. Teacher's questions are primarily directed toward knowledge of scientific concepts and their connections and applications. Occasionally questions are used to clarify students' ideas, are goal oriented, and emerge from students' responses. 9D. Multiple forms of assessment. Some assess students' knowledge and some assess students' understanding. 10B. Uses of assessment in addition to grading is for checking students' knowledge. 11C. Teacher investigates students' ideas about subject matter and works to alter "unscientific" ideas.
STUDENT'S ACTIONS: 12D. Students occasionally use writing and other representations of ideas as part of developing their understanding and constructing meaning. Much is reconfiguring information provided. 13C. Student questions focus on clarification of meaning related to specific concepts or procedure. 14D. Some student-student interaction directed toward understanding and applying scientific ideas. Some about procedure. 15C. Students volunteer some examples related to class activities. 16C. Students accept procedure and role.
RESOURCES**:** 17D. Multiple resources including manipulatives (mirrors, slinky, flashlights, saran wrap, etc.) are used. 18C, 18D. Resources are related to content and illustrate ideas. Some resources are used to aid students' understanding and application of ideas. 19B. Access to resources controlled by teacher.
ENVIRONMENT: 20C. Decision-making is teacher-controlled with some sharing of decision-making with students about use of time. 21B. Some teaching aids displayed, but may not be related to content. 22D. Students' work displayed includes some student creations (posters, graphs).
OTHER: Classroom arrangement includes students seated in pairs within the classroom. Students move as directed to work in groups of 4 as part of daily activities.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 18. Continued.

Table 28. STAM Summary Scores - Shannon (T4).

	1A Didactic	2B Transitional	3C Conceptual	4D Early Constructivist	5E Experienced Constructivist
Content - C; Rows 1-4 Summary: Pre= 2/3 Post= 3/4					
1			■ ●	●	
2			■ ●		
3		■	●		
4		■	■ ●	●	
Teacher's Actions - TA; Rows 5-11: Pre=2/3 Post= 3/4					
5			■	●	
6			■	●	
7			■ ●	●	
8			■ ●	●	
9			■	●	
10		■ ●			
11			■ ●		
Student's Actions - SA; Rows 12-16 Summary: Pre=2/3 Post= 3/4					
12			■	●	
13	■	■	●		
14	■	■		●	
15		■	■ ●		
16			■ ●		
Resources - R; Rows 17-19 Summary: Pre= 2/3 Post=3/4					
17		■		●	
18			■ ●	■ ●	
19		■ ●			
Environment - E; Rows 20-22 Summary: Pre= 1/2 Post=3					
20	■		●		
21		■ ●			
22	■			●	
Total STAM Summary: ■ Pre-Observations = 2.4 ● Post-Observations = 3.3					

Notes: Summary values written with slash indicate score wobbles within range. Teaching styles (A-E) were coded with numbers (1-5) for the purpose of calculating a numerical average displayed in Figure 19.

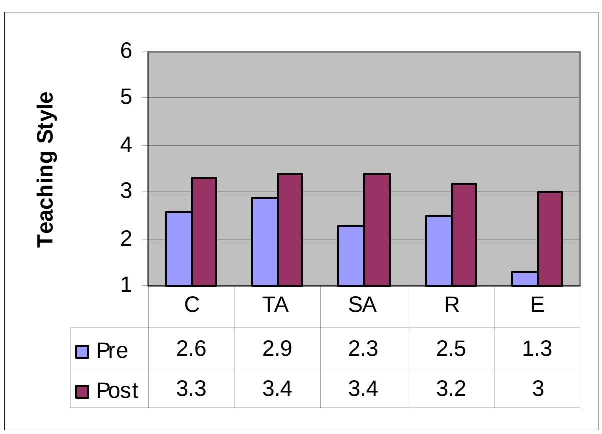


Figure 19. Shannon's Summary STAM Scores.

constrained by the lack of materials. Shannon tried to promote a positive atmosphere in her classroom by getting to know her students and using that knowledge for grouping students according to abilities and personalities. She used formal (tests) and informal (questioning) assessments to evaluate her students. When particular students did not understand concepts, she provided extra group work and one-on-one work to help them prepare to move on with the rest of the class.

Shannon attributed participation in system-wide technology training for improving her use of technology during her first year of teaching. During her post-interview (second year of teaching) she stated that she was on several committees within her school; she was a mentor; and she had participated in numerous professional development courses which she claimed influenced her teaching. She accommodated for student diversity conceptually by modifying their work and by using peer tutoring. Shannon's pre- and post averages for Teacher Action style wobbled between transitional and conceptual at 2.6 and 2.4 respectively. Teacher Action excerpts are located in Table 29.

SIDESTEP analysis.

Shannon used a "go-around" cup (*Project Grad* strategy) to ensure that all students were called on equally during lessons. She stated that she addressed "special needs" students with peer and adult tutoring, lesson and homework modification, small group work, use of manipulatives, and reading instructions and tests to students. She used the system-wide adopted textbook for science instruction. She reported the use of group work, worksheets, discussions, standardized tests, essays, projects, oral reports,

Table 29. TPPI Interview Codes and Transcript Statements for Shannon (T4) Pre and Post - Question One.

	Three Categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
A	Pre: "I just follow the curriculum and there's not much time to fit in anything else." (18) Pre: "A constraint to using hands-on activities is having enough items depending on what you're using." (23) Pre: "It's also hard to find enough time to talk with some of the other teachers and learn from them." (23)		
B	*Post: "I would actually go a little bit further and do a formal assessment." (19)* Pre: "I try to create a positive feeling in the room. I ask them to tell me what they don't understand and find out how I can help them understand better." (33)		Pre: "I seat them with students who typically understand and finish early and need more stimulation and actually do want to help others." (38)
C	Pre: "I have done a lot of peer tutoring (teacher to teacher) but it has been on a different grade level and so it's still helpful, but I'd like to have more one on one with someone and get their suggestion on my grade level." (24)	Pre: "At the local level I am involved in a program incorporating technology into the classroom called, *In-TECH*. We do group work, presentations, and it's been really good because a lot of the things for that class as my homework, I've used it with my kids." (25) *Post: "Now I'm on other committees and I've been to quite a few seminars and professional development courses, so all of those together actually influence the way I teach. Talking with mentors and being a mentor myself just kind of adds a little bit to that." (25)*	Pre: "I understand that I have to learn about them first and then modify their work. We keep individual small goals and I do a lot of peer tutoring." (38)

Table 29. Continued.

	Three Categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
D	Pre: "I try to make sure that I group them according to abilities and personalities, because that definitely gets in the way when you are trying to get an objective across if two are fighting because they don't like each other." (33)		
E	Pre: "After you get to know your students you can tell and see whether or not they're actually getting it. I never just sit at my desk. I'm on my feet constantly and asking them questions to show me what they can do and I can tell if they can produce what I'm wanting or not." (19) *Post: "For those who don't get it I go back and do small group work, one-on-one work, and make sure that they are ready to move on as well as the rest of the class." (19)*		

and multiple choice and true/false tests before and after the PI class. She incorporated concept maps and quizzes after PI participation. Her top two goals for students' learning in science included: "they learn to think and ask why and they learn to perform experiments with accuracy."

Summary of Shannon's results for research question one.

STAM analysis revealed that Shannon exhibited primarily transitional and conceptual behaviors during pre observations, with a total STAM summary average of 2.4. During post-observations, she exhibited primarily conceptual and early constructivist behaviors, with a total STAM summary average of 3.3. Her pre summary STAM averages: increased from an average between transitional and conceptual for four of the five classroom aspects measured (Content, Teacher Actions, Student Actions, and Resources); and increased from a didactic/transitional (1.3) average to a conceptual (3.0) average for Environment.

Analysis of Shannon's TPPI interview questions (beliefs) revealed that her pre and post average for Teacher Actions (TA) showed negligible change (from 2.6 to 2.4 - transitional/conceptual). These averages indicated more teacher-centered beliefs for TA, which were similar to her pre-STAM TA average of 2.9 but were less constructivist than her post-STAM average of 3.4.

III. Research Question Two Analysis

> "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

Interview analysis.

Interview analysis for Research Question two includes the analysis of the ten questions listed in Table 4 for Student Actions and Teacher's Philosophy of Teaching. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Student Actions and Teacher's Philosophy of Teaching can be located in Appendix C.4.

Shannon expressed primarily teacher-centered and conceptual styles for Student Actions (SA) prior to and at the completion of the PI course. She believed that students learned best by seeing, doing, and experiencing. She knew that students understood concepts when they could put them in their own words and by checking their work daily. Shannon felt that students valued their experience in her classroom because she tried to make it fun and she took the time to help them. Shannon's pre- and post- averages for SA were conceptual with an average of 3.0. SA excerpts for Shannon are located in Table 30.

Shannon's Philosophy of Teaching (PT) ranged from teacher-centered to conceptual, to student centered teaching styles prior to and at the completion of the PI course. She described herself as being a positive and caring teacher who puts forth a great deal of effort. She pictured good learners as those who make good eye contact, listen well, and are confident. Shannon felt that her students valued learning how activities they conducted in class could be used later in life. Her best learning experience was an opportunity to work as part of a group doing hands-on activities. She, in turn tried to model this experience by using creative, hands-on lessons within her own classroom. Her greatest strengths included flexibility and teaching to student's individual needs. She would like to put more effort and creativity into her lessons but, "right now I

Table 30. TPPI Interview Codes and Transcript Statements for Shannon (T4) Pre and Post - Question Two.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
A			Pre: "Good learners listen and have good eye contact." (13) Pre: "This teacher surprised us as adults and so I know it will do the same with children and I think that was the best experience." (21)	Pre: "I would like to improve getting the lessons that hit the goal best and yet are still creative, fun, and interesting." (40) *Post: "I want to put forth more time and effort on specific lessons and then keep building on that." (40)*
B	Pre: "They learn by seeing." (29) Pre: "I see their work, I check it efficiently that day or that afternoon. I know who got my lesson and I know what I need to do the next day." (30)			
C	Pre: "They learn by doing and experiencing. It's not enough for someone to tell them and to let their own imaginations figure out what you are trying to say. They have to experience it themselves." (29) Pre: "They've got to put it in their own words and come up with a way to show me that they know it. For example, we don't just look at the meanings of the words, we draw a picture that has to do with that situation. I can tell in a second whether or not they have the right meaning. Sometimes they take the meanings literally and it's kind of funny to see the difference. You can tell what they understand." (30)		Pre: "I think I am positive and caring and put forth a lot more effort than I've seen others do. I try to structure lessons that are fun and meet the objectives." (1) Pre: "One of the biggest things that I do in lessons is I tell them when they will use this later in life. We talk about professions and when they would use it at home so that when you are teaching the concept they are not just going, 'why am I doing this, this is boring'." (20)	

Table 30. Continued.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
C			Pre: "I try to use creative, hands-on lessons." (22)	
D		Pre: "I've had 2-3 students tell me at different times, you know you're my favorite teacher because you took the time to help me." (37) *Post: "Just to let them know we can have fun. We can work and support each other. I will support them and help them and I want them to help others to enjoy learning."* (37)	Pre: "They have to be confident in themselves. They can't be down on themselves and negative when they make a mistake or overconfident because that will be an impairment as well. Someone who is willing to try things to learn instead of just waiting to be told." (13) Pre: "She (a college professor) brought examples and I think one day we were learning about an explorer and she brought an example and dressed up. And then she let us work in groups and so we had hands-on experience and lots of visuals, and we got to explore all of the things that she had collected." (21)	Pre: "I am able to be flexible when I see, that everything is planned out and all of a sudden I see that my kids might not be understanding and so I stop and let them get it and I reteach until I see that they are actually learning." (39) *Post: "I see the students as individuals and am able to work with them individually and not expect the same thing from every student. I think I am caring and have a good rapport with students and I think that's pretty important." (39)* Pre: "I need to improve creativity." (40) *Post: "Right now I just can only do what I can do to get by and I think if I put more effort into it now that later on the students and I will benefit. So basically just working harder than I already am." (40)*

can only do what I can to get by." Shannon's pre- and post-averages for PT wobbled between transitional and conceptual with an average of 2.9. PT excerpts for Shannon are located in Table 30.

Constructivist Learning Environment Survey - CLES analysis.

Shannon's pre (26) and post (24) Personal Relevance scores were in the high intermediate agreement range, which indicated that she often but not always emphasized a linkage between school science and students' everyday experiences (see Appendix F.3 for calculations). Her pre (24) and post (20) Critical Voice scores decreased notably from a high to low intermediate agreement range. This indicated that after Shannon's participation in the PI course she provided fewer opportunities for students to question her plans and methods and express concerns about impediments to their learning. Her pre (18) and post (19) Shared Control scores were in the low intermediate agreement range, which indicated that students are sometimes invited to: participate in designing their own learning activities; determine assessment criteria; and negotiate the norms of the classroom. Her pre (26) and post (24) Student Negotiation Scale were in the high intermediate agreement range and indicated that she often but not always provided opportunities for students to: explain their ideas to other students; to make sense of other students' ideas; and to reflect on the viability of their own ideas. Her pre (25.5) and post (26) Attitude Scale scores were in the high intermediate agreement range, which indicated that she felt students: often anticipated the activities within her classroom; found the activities worthwhile; and understood and enjoyed the activities. Shannon's CLES scores are exhibited in Figure 20.

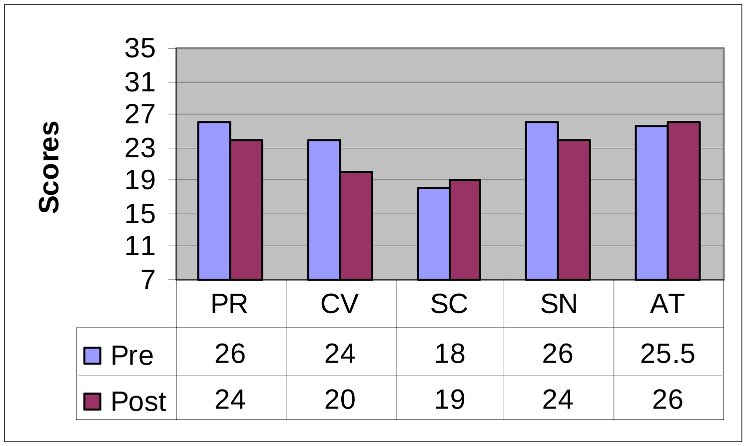


Figure 20. Shannon's CLES Scores.

Science Teaching Efficacy Belief Instrument - STEBI analysis.

Shannon's Personal Science Teaching Efficacy Belief subscale scores for the pre and post assessments increased notably within the high efficacy category and were 49 points and 60 points respectively (max=65 points). Therefore, after participation in the PI course, she was more comfortable with her ability to teach science. Her Outcome Expectancy subscale scores for the pre and post assessments decreased slightly from 48 to 46 points (max=60 points); however, both scores were in the high expectancy category and indicated that she had confidence in her teaching ability to create desirable outcomes (see Appendix G.2 for calculations).

Reflective journal questions.

Shannon described a love for science and a desire to learn about conducting long-term experiments with students (Excerpt A). She expressed a concern regarding time constraints to fit in inquiry-based learning into classroom activities (Excerpt B). She also

felt the experience of going to the state science teacher conference would be worthwhile and the experience of presenting would be good for her professional development.

Excerpt A (4/20/03) "I really love to teach science because there are so many different opportunities for experiments and hands-on lessons. This is really what kids need in order to be engaged in the lesson and in order to remember the content of the lesson for longer periods of time. I have always been a learner who really understands by DOING and TOUCHING, instead of just listening. I feel like I provide a good background in science to my students, give them opportunities for hands-on lessons, and give a positive energy to them. But, I know that I am missing one of the most important concepts of science---experimenting for longer periods than 1 hour lessons. My students have not been exposed to any experiments that took longer than 1 class period where they were able to sketch, think, write, or discuss their predictions vs. the results. It is always said verbally in class and then we move on. Hopefully I will learn some things about journaling that I can use next year."

Excerpt B (10/2/03) "I really feel excited about doing inquiry based lessons in the classroom. My problem now is just finding class time to fit in inquiry lessons with the fish or pill bugs. I really want my students to see and research the pill bugs this year. I will have to make time for this because they are very excited to learn new things (especially when it comes to bugs and fish)."

Excerpt C (10/3/03) "I am excited to go to the TSTA conference. I really feel like I will learn a lot and that I will get good ideas and materials for teaching. I am looking forward to the seminars and the whole experience itself. It is good to get ideas from other teachers, but even better when you can get them from the 'big-wigs.' By the way, it doesn't hurt to have a presentation on a resume either!"

Summary of Shannon's results for research question two.

TPPI analysis of Shannon's pre and post Student Actions (SA) and Philosophy of Teaching revealed that she held conceptual beliefs. Her behaviors for the pre-STAM SA observations were close to transitional and her behaviors were between conceptual and early constructivist for her post-STAM SA observations. Therefore, her behaviors became more congruent and somewhat more constructivist than her beliefs.

Shannon's pre and post CLES scores for Personal Relevance, Student Negotiation, and Attitude scores were in the high intermediate agreement range. Several interview

responses correlated with these subscales including how she sees students as individuals and does not expect the same thing from each of them and her desire to meet objectives, yet have fun. Her CLES Critical Voice scores dropped from high to low intermediate agreement and her Shared Control scores remained at low intermediate agreement. She described that she spent a great deal of time planning and delivering lessons to meet goals and this could be indicative of allowing less student control. Her TPPI questions, discussed previously, revealed beliefs that became more conceptual which can lead to a combination of student and teacher-centered behaviors. During post observations, Shannon also indicated that her students were more oppositional than her previous year's students which could also lead to a drop in her efforts to allow student control and opportunities to for them to voice their opinions.

Shannon became more confident in her ability to teach science after PI participation, as revealed by her STEBI, Personal Science Teaching Efficacy Belief scale scores. Her beliefs in her ability to create desirable outcomes were in the lower range of the high expectancy category of the STEBI, Outcome Expectancy scores. According to Shannon's journal reflections, she already "loved" science prior to PI participation but had a desire to incorporate more long-term experiments. She cited time constraints to incorporating inquiry-based learning into classroom activities after PI participation.

IV. Research Question Three Analysis

> "Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

Interview analysis.

Interview analysis for Research Question three includes the analysis of the three questions listed in Table 4 for Teacher and Content. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher and Content can be located in Appendix C.4. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Shannon expressed equally teacher-centered and student-centered statements for Teacher and Content (TC) prior to and at the completion of the PI course. She stated that science is about asking why more than anything else. She valued science because "it affects our lives everyday …Science is a big basis for other learning." She believed that students should learn about the nature of science, not all hypotheses will turn out the way they think they will, and relate more to how scientists actually work in the real world. "I would actually teach my students how to test, analyze, research, conduct experiments accurately, and teach them ways to learn from data." Shannon's pre and post TC average of 2.5 wobbled between transitional and conceptual. Shannon's TC excerpts can be located in Table 31.

When asked to define inquiry, Shannon provided a limited view before PI course participation. However, during the post-interview she described a more complete definition of inquiry, toward the idea of open/full inquiry.

Table 31. TPPI Interview Codes and Transcript Statements for Shannon (T4) Pre and Post - Question Three.

Style	Teacher and Content (14, 28, 34)
A	Pre: "Science is experimenting, thinking, learning about why things are the way they are. It's not just learning this is the way you do this, this is what happened in history, this is how you measure, it's *why* more than anything else. That's a big part of science, I think you always have to ask why." (14)
B	Pre: "I just know that for me, science just has so many opportunities to have visuals and again we're back to the hands-on, it's just so interesting for me." (28)
	Post: "I value that science actually affects our lives everyday, things that we don't even think about that its' in our lives everyday and we don't even realize it that much. That science is a big basis for other learning and it's why things are the way they are sometimes." (28)
C	Pre: "It's not enough to just meet the objectives in science, because the objectives are subject-specific. You talk about light and sound and then you get those questions that are science related (referring to standardized testing) that they can't answer because you didn't talk about graphs with this or because you didn't talk about in general how would you solve this problem." (34)
	Pre: "I would let them know that hypotheses are not always going to turn out the way they think and that's OK and relate that more to how scientists actually work in the real world." (34)
D	Pre: "Science is so personal. Everybody has a body, everybody has this system, everybody has plants around them. We all live in a world and all of the things that you can talk about in science become personal and I think that it affects kids that way and I know that it's affected me." (28)
	Pre: "I need to pull in more of the in general how would you think about any science process, how would you research." (34)
	Post: "I would actually teach my students how to test, analyze, hypothesize, research, conduct experiments accurately, and teach them ways to learn from data." (34)

4/15/03 (Pre-interview) "I would say that would be just the thinking process of trying to find out the reason why for anything. Figuring out the steps that it takes to think through something and doing those steps."

11/14/03 (Post-interview) "Scientific inquiry is letting students get interested enough in something that they want to ask questions about it and let them focus on questions and try to find an answer or a conclusion or some type of data for that and do the research and the experiments themselves. Set up the things themselves and let the teacher become the facilitator and someone to help guide and direct but not someone who is doing all the work. Let the students do the work and the thinking and let the teacher stand back and help when it's necessary."

When asked to describe experiences learning and teaching by inquiry she described more of an activity approach than an inquiry approach prior to PI course participation (Excerpt A and B). Her experience describing her college course (Excerpt A) sounded like inquiry; however, the lesson that she described that was created from the course (Excerpt B) was an activity. During her post-interview she expressed frustration (which is common to being introduced to inquiry-based learning) and the desire to have more opportunities to experience inquiry-based learning in order to have more confidence with transfer to her own teaching (Excerpt C).

Excerpt A - 4/15/03 (Pre-interview) "Ok, I did have a class in college on science inquiry, and it was a very good class. We just did experiments and research ourselves and we learned by doing, it was a very active class and um, we taught lessons in there and actually the lesson that I taught for my peers in there is the lesson that I'm teaching now. And I'm taking the same thing that I would have never found, but since I did it for that class I knew exactly where to go get it."

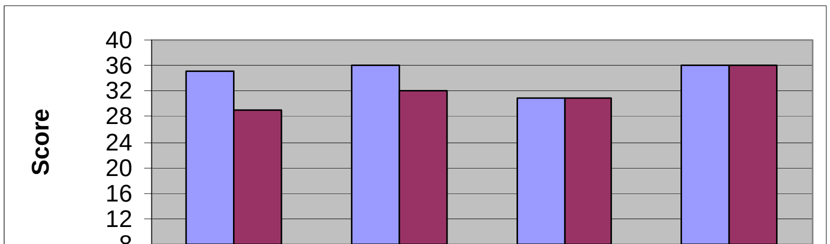
Excerpt B - 4/15/03 (Pre-interview) "It is on the skeletal system and your joints in your body and how bones help. And we talk about you have to have the joints and you have to have the bones that work together or else you will be a blob. We tape our hands and we go without using joints and we walk without bending our knees and we do all of the things in class and the kids like it because they are moving around and doing and it's fun. But they still see the point, you know, you have to have joints and you have to have all of these things. They also built the skeletal system and learned the different names of the bones and how they help and which body parts they protect and all of those things." *(Note: She taught the lesson for her pre-observations and during discussion of her STAM*

analysis in the summer session, she described how it was not really inquiry because she was doing most of the work and the students were not developing questions.)

Excerpt C - 11/14/03 (Post-interview) "My experience with learning inquiry was really different because I'm used to being structured and I'm used to creating structure for lessons and I was basically turned loose with other students and we were confused and frustrated. But, we were really interested and we really liked it and I think it was good because we were the ones that were doing the thinking. To go back and do it again, I would probably do so much better because I was scared that I was going to go in the wrong directions and now I realize that there's really not a wrong direction as long as I'm doing something and working toward some goal of my own. So I think the more inquiry experiences that I have the better and better they will get for me and the better and better that I will get at teaching them."

Modified Nature of Scientific Knowledge Scale - MNSKS analysis.

Shannon's MNSKS subscale scores, Figure 21, were within the accepted view of the Nature of Science (above a score of 24; see Appendix H.2 for calculations). Her testable and unified subscale scores did not change from pre to post assessment. However, both her creative and developmental subscale scores decreased notably, four points, from pre to post assessment. Shannon's Total MNSKS Scale Score decreased



	Creative	Developmental	Testable	Unified
Pre	35	36	31	36
Post	29	32	31	36

Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 21. Shannon's MNSKS Scores.

from 138 to 128 from the pre to post assessment; however, both scores are toward the accepted view of the NOS (above 96).

Constructivist Learning Environment Survey - CLES analysis.

Shannon's pre (19) and post (22) Scientific Uncertainty Scale scores increased slightly from a range of "seldom to sometimes" to a range of "sometimes to often" after participation in the PI course. This indicates that Shannon sometimes provided opportunities for students to learn that scientific knowledge is: evolving and provisional; shaped by social and cultural influences; and arises from human interests and values.

Reflective journal questions.

Shannon wrote one journal entry about the process of learning to develop experimental design and the trial and error of experimentation.

5/28/03 "I have really been experimenting with my pill bugs more lately because school is now out. I have learned that it is much more difficult to set up GOOD experiments than I thought. I tried an experiment with the 5 Petri dishes that I borrowed from class. I used 5 bugs, putting them in the center dish, to see which direction they would go more (to cornmeal, to water, to a potato slice, or to an empty dish). My experiment was ruined because I didn't take into account that the bugs cannot really move around well in the slick dishes. They all turned over on their backs and weren't able to move. So, basically I am just learning how to set up experiments that actually will work well."

Summary of Shannon's results for research question three.

Analysis of Shannon's pre and post Teacher and Content beliefs revealed teacher-centered scores ranging between transitional and conceptual. Her MNSKS subscale scores were all in the range of "toward the accepted view of the NOS." Two of the subscale scores, Creative and Developmental, decreased four points each, while the other two subscales remained the same (Testable and Unified). Her CLES Scientific

Uncertainty scores remained close to the level of "sometimes": indicating she gave students some opportunities to view science as tentative.

Shannon had a better understanding of the meaning of scientific inquiry after PI participation. She described an "activity" approach to learning and teaching by inquiry prior to the PI course. After the course, she described the class as being completely different from other learning she had experienced before. She credited the course for inspiring her to seek more experiences in inquiry-based learning and for inspiring her to provide these opportunities for her own students.

V. Research Question Four Analysis

> "Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

Mentoring Efficacy Questionnaire - MEQ analysis.

Shannon's pre MEQ score of 56 (out of 100) points, a low intermediate efficacy score, increased notably to a post-score of 69 points, a high intermediate efficacy. She indicated that she agreed that she was confident in helping a protégé implement inquiry-based science instruction prior to and at the completion of the Project INQUIRE course (Question 20).

Prior to the PI course, Shannon indicated her greatest strengths as a science mentor as "the love for science, the energy that I supply as a teacher/mentor, the ability to listen, and some experience with creative/hands-on lessons;" and her greatest challenge was "the fact that I am a new science teacher, inexperienced, and have a loss of patience for completing experiments with complete accuracy." After taking the PI course, she

indicated her greatest strength as "the ability to listen and encourage each teacher. I will help them in areas that they need individually, not just the same thing with every teacher." Her greatest challenge was time, "I never have extra time to mentor. I always have to give something up of my own in order to help them."

Reflective journal questions.

Shannon described an excitement to mentor other teachers within her school in using the inquiry-based process for science (Excerpt A and B).

Excerpt A (7/15/03) "I am very interested in mentoring other teachers at my grade level, as well as those in the 4th grade program. I will be one of the two teachers left on the 5th grade team (out of 6 teachers) so I will have plenty of opportunities to share my knowledge of inquiry to the "new" teachers at my school. I am also very close with the 4th grade team and I will share with them as well. I will probably be able to do this through my planning time. I tend to plan with the 4th grade team and get ideas and suggestions from them. Now I will be able to share with them how to take the problem-solving activities from the textbook and turn them into inquiry activities. Most of the team is made up of very interested teachers who will be willing to try new things. As for the new 5th grade team, well, we'll see."

Excerpt B (10/2/03) "I am enjoying my meetings with the mentoring team this year. It really feels good to be a part of the "team" and to help new teachers in the building. I am actually a mentor for two new 5th grade teachers."

Summary of Shannon's results for question four.

Shannon's Mentoring Efficacy Questionnaire scores increased following PI participation. In addition to PI participation, she received Urban IMPACT's Mentor Training and joined her school's mentoring team. She indicated she felt confident mentoring other teachers in inquiry-based instruction prior to and after the class. She expressed a desire to mentor other teachers within her school; however, she claimed that it was difficult for her to give up her time to mentor.

VI. Participant Summary

Table 32 is a data matrix for Shannon that provides an overall picture of her results for the Project INQUIRE assessments. Shannon's behaviors became more student-centered (conceptual/early constructivist) after PI course participation as measured by STAM analysis. Her beliefs as measured by the TPPI instrument for Teacher Actions, Student Actions, Philosophy of Teaching, and Teacher and Content were within the teacher-centered to conceptual range before and after the course. Her beliefs as measured by three of the CLES subscales (PR, SN, and AT) were student-centered. Two of the CLES subscales (CV and SC) portrayed more teacher-centered views of less student control and voice. Therefore, her beliefs as measured by the TPPI interview and CLES instrument revealed a mixture of teacher- and student-centered beliefs which correlate with her emergent student-centered behaviors. Her perceived efficacy in teaching science improved after taking the course as measured by the STEBI and journal entries, while her outcome expectancy beliefs remained within the high expectancy category. Constraints cited for teaching by inquiry include lack of planning time to prepare the lessons and class time to conduct them.

Shannon's knowledge of scientific literacy issues improved after PI participation. In particular, her knowledge regarding the definition of scientific inquiry was broadened. Her knowledge of NOS issues as measured by the MNSKS were toward the accepted views of NOS; however, her view of science as tentative decreased slightly after the course as measured by the MNSKS Developmental and CLES Scientific Uncertainty scales. She expressed confidence in mentoring other colleagues to use inquiry-based instruction before and after the course. She was enthusiastic about mentoring other

Table 32. Project INQUIRE Data Matrix - Shannon (T4).

<table>
<tr><td colspan="11">Teacher Information: 5th grade; 1st year teaching experience</td></tr>
<tr><td colspan="11">Question One: Do teachers who complete Project INQUIRE change their instructional practices?</td></tr>
<tr><td rowspan="3">STAM[a] Averages
T=Teacher
S=Student</td><td colspan="2">Content</td><td colspan="2">T. actions</td><td colspan="2">S. actions</td><td colspan="2">Resources</td><td colspan="2">Environment</td></tr>
<tr><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td></tr>
<tr><td>2.6</td><td>3.3</td><td>2.9</td><td>3.4</td><td>2.3</td><td>3.4</td><td>2.5</td><td>3.2</td><td>1.3</td><td>3.0</td></tr>
<tr><td>Total STAM Summary</td><td colspan="5">Pre: 2.4 Transitional/Conceptual</td><td colspan="5">Post: 3.3 Conceptual/Early Constructivist</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.6</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.4</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="11">Question Two: Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction?</td></tr>
<tr><td rowspan="2">TPPI[a] - Student Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 3.0</td><td colspan="6">Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 3.0</td><td colspan="6">Conceptual</td></tr>
<tr><td rowspan="2">TPPI[a] - Philosophy of Teaching</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.9</td><td colspan="6">Close to Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.9</td><td colspan="6">Close to Conceptual</td></tr>
<tr><td>CLES -
Personal Relevance
Critical Voice*
Shared Control
Student Negotiation
Attitude</td><td colspan="2">Pre
26
24
18
26
25.5</td><td colspan="2">Post
24
20
19
24
26</td><td colspan="6"><u>Scores</u>:
7-13 = Low
14-20 = Low Intermediate
21-27 = High Intermediate
28-35 = High</td></tr>
<tr><td>STEBI -
Personal efficacy-PE*
Outcome expectancy-OE</td><td colspan="2">Pre
49
48</td><td colspan="2">Post
60
46</td><td colspan="6"><u>PE Scores</u>: 13-30 = Low; 31-48 = Average; 49-65 = High efficacy
<u>OE Scores</u>: 12-28 = Low; 29-44 = Average; 45-60 = High expectancy</td></tr>
<tr><td colspan="11">Questions Three: Do teachers who complete Project INQUIRE change their understanding of scientific literacy?</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher and Content</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.5</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.5</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td>MNSKS:
Creative*
Developmental*
Testable
Unified
Total</td><td colspan="2">Pre
35
36
31
36
138</td><td colspan="2">Post
29
32
31
36
128</td><td colspan="6"><u>Scores</u>:
8-23 = Unaccepted view (32-95 - Total)
24 = Neutral view (96 - Total)
25-40 = Accepted view (97-160 - Total)</td></tr>
<tr><td>CLES - Scientific Uncertainty</td><td colspan="2">Pre: 19</td><td colspan="2">Post: 22</td><td colspan="6">See Scale Scores in question two.</td></tr>
<tr><td rowspan="2">Inquiry - Definition and Experience Teaching (T) or Learning (L)</td><td colspan="2">Definition Pre</td><td colspan="2">Experience Pre (T) & (L)</td><td colspan="3">Definition Post</td><td colspan="3">Experience Post</td></tr>
<tr><td colspan="2">Activity</td><td colspan="2">Activity</td><td colspan="3">Open/Full inquiry</td><td colspan="3">(L) Open inquiry</td></tr>
<tr><td colspan="11">Question Four: Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues?</td></tr>
<tr><td>Mentoring Efficacy
Total*
Question #20[b]</td><td colspan="2">Pre
56
Agreed</td><td colspan="2">Post
69
Agreed</td><td colspan="6"><u>Scores</u>:
20-40 = Low; 41-60 = Low Intermediate; 61-80 = High Intermediate; 81-100 = High</td></tr>
</table>

Note: *=notable change. [a]TPPI & STAM scale: 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist. [b]Did participant rate self as confident in ability to mentor protégé with inquiry-based instruction?

teachers to use inquiry-based instruction; however, as a second year teacher (at the end of the study) she expressed concerns about giving up her time to mentor.

Case Study T5 - Laura

I. Basic Demographic Information

Laura, a non-Hispanic White female, was an experienced teacher in her 13th year of teaching during the 2002-2003 school year in which she taught three sections of 6th grade physical science and three sections of social studies at an urban middle school. She taught four sections of 6th grade physical science and one section of reading during the 2003-2004 year at the same school. Her non-teaching assignments included science club sponsor, hall and bus duty, and homeroom supervisor. She indicated spending over 20 hours per week for science preparation prior to and at the completion of the PI course.

Laura was not a member of her school's mentor core team and did not receive Urban IMPACT's mentor training during the 2003-2004 school year due to a conflict with a science professional development workshop required by the school district. She had attended the state science teacher conference within the past year, prior to participation in the PI course. Although she had not conducted any presentations at conferences prior to the course, she was a member of TSTA and NSTA. She had completed two *Annenberg*, online video courses during the Summer of 2002 including *Science in Focus: Energy* and *Science in Focus: Force and Motion*. After completing PI, she became a member of the Association for the Education of Teachers of Science (AETS) and presented information regarding the PI course at two conferences: TSTA

and the international conference of AETS. Laura also decided to pursue a PhD program in teacher education beginning in the 2004-2005 school year.

Laura's school serves 6^{th}-8^{th} grade students, of which 59.8% are economically disadvantaged. The demographics of the student body are 67.4% White, 28.3% African American, 2.6% Hispanic, 1.3% Asian, 0.3% Native American, and 0.1% Pacific Islander. The demographics of the two classes that were observed for the pre-observations are described in Table 33. Laura provided the demographics for her entire teaching load for the 2003-2004 school year (post) because observations were made in several classes.   She had a total of 60 students in the two pre-observation classes and 86 students in the 2003-2004 school year.

II. Research Question One Analysis

"Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?"

STAM analysis.

Laura's STAM Video Portfolio for pre and post observations can be found in Figure 22. The Video Portfolio provides an overview of the participant's instruction as well as a description of the teaching style observed for each of the 22 teaching aspects of

Table 33. Laura's Class Demographics Pre- and Post- Observations (T5).

	Males		Females	
	Pre	Post	Pre	Post
African American	6	12	4	12
Hispanic		1		1
White	20	33	30	27
Totals	26	46	34	40

STAM Pre-Observations
OVERVIEW The focus of these lessons was on Newton's laws and energy. Day one included discussions between the students and teacher of the first law and activities in which pairs of students used balls (ping pong and golf) to construct an understanding of the first law. Day two included activities in which pairs of students practiced Newton's 2nd and 3rd laws and teacher-guided discussions and demonstrations of the laws. Day three included a discussion of energy; paired practice and a group discussion of the kinds of energy present when dropping a ball; and an opportunity for students to review energy concepts with a partner. The classes are student-centered and the teaching is best described as early to experienced constructivist. Transitional -1 ; Conceptual - 2.5; Early Constructivist - 10.5; Experienced Constructivist - 8[a]
CONTENT: 1D[b]. Teacher and students negotiate understanding of key ideas with teacher's content emphasized. 2D, 2E. Through discussions each day the teacher leads students in using examples and constructing connections to real world events, related ideas, and key ideas about Newton's laws and energy. Students are also given the opportunity daily to construct connections with the teacher's guidance through carefully structured activities. 3D. Teacher leads students to identify limits and exceptions that may generate alternate explanations. 4D, 4E. Teacher leads students to identify limits and exceptions that may generate alternate ways of representing or interpreting observations and events through discussions of Newton and the results of activities completed in class. Students complete multiple hands-on activities that demonstrate Newton's laws and aspects of energy with teacher's guidance.
TEACHER'S ACTIONS: 5E. The video segments reflect extensive use of student-centered methods including discussions and group activities. 6D. Investigations, demonstrations, and hands-on activities with multiple manipulatives are lead by teacher and incorporate some students' ideas. 7D, 7E. Teacher and student interaction occurred during discussions concerning clarification and usefulness of students' ideas and understanding is teacher-directed. During hands-on activities, students interact with each other as well as receive teacher input into the clarification and usefulness of their ideas and understandings. 8D, 8E. Teacher questions are goal-oriented and occasionally to frequently emerge from students' responses. They are used to clarify students' ideas. 9D, 9E. Assessment is nearly constant through discussion. Students also demonstrate understanding through practicing concept applications during hands-on activities. 10D, 10E. Discussion is used to guide the teacher and students in adjusting and carrying out activities and to assess students' knowledge. 11E. Teacher actively seeks students' ideas. Assessment drives instructional decision-making.
STUDENT'S ACTIONS: 12D. Students occasionally use writing and other representations of ideas as part of developing their understanding and constructing meaning. Much is reconfiguring information provided. 13E. Student questions address key ideas, their connections and applications. 14E. Student-student interaction directed toward understanding and applying scientific ideas. Students are self-reliant. 15E. Students volunteer analysis as well as examples. Most are pertinent to class activities. 16C. Students accept procedures and role.
RESOURCES: 17D. Multiple resources (balls, marbles, balloons, Kinex materials) are available. 18D. Some resources are used to aid students' understanding and application of ideas. 19C, 19D. Access to resources is at times controlled and at times guided by teacher, but there is some discussion of access with students.
ENVIRONMENT: 20C. Teacher-controlled. Some sharing of decision-making with students about use of time. 21B. Some teaching aids displayed unrelated to content. 22D. Students' work displayed in a teacher-created scrapbook including student graphs and pictures of students working.
OTHER: Room arrangement: Students are seated in pairs at tables for class discussions and are often completing activities on the floor.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 22. Summary of Video Portfolio - Laura (T5).

STAM Post-Observations
OVERVIEW: The focus of these lessons was simple machines. Day one included a discussion and correction of notes taken by students in the library during the previous three class periods with an emphasis on the teacher's content. Day two included an opportunity for students to create concept maps regarding simple machines in the computer lab using the software *Inspiration*. Day three and four included student work in seven simple machine stations setup around teacher's classroom: inclined planes, friction, pulleys, wheel & axle, wedges, screws, and levers. The classes are student-centered and the teaching is best described as early to experienced constructivist. There are several elements of conceptual style teaching as well. Didactic - 1; Transitional - 1; Conceptual - 3; Early Constructivist - 10.5; Experienced Constructivist - 6.5[a]
CONTENT: 1D[b]. Teacher and students negotiate understanding of key ideas with teacher's content emphasized. 2D. Teacher leads students in using examples and constructing connections to real world events, related ideas, and key ideas of simple machines. 3D. Teacher leads students to identify limits and exceptions that may generate alternate explanations. 4D. Teacher leads students to reconstruct how evidence has been used to formulate scientific ideas and to use scientific processes to formulate and evaluate ideas.
TEACHER'S ACTIONS: 5E. The video segments reflect extensive use of student-centered methods including discussions and group activities. 6C, 6D. Investigations, demonstrations, and hands-on activities lead by teacher and incorporate some students' ideas. Some "answers" known ahead of time. 7D. Teacher-student interaction about clarification and usefulness of students' ideas and understanding is teacher-directed. 8E. Teachers' questions are goal-oriented and frequently emerge from students' responses. They are used to clarify students' ideas. 9E. Assessment is nearly constant through discussion. Students also demonstrate understanding through self-assessment, practicing concept applications during hands-on activities, and using a journal. 10D. Assessment is used to guide teacher in adjusting activities. 11E. Teacher actively seeks students' ideas. Assessment drives instructional decision-making.
STUDENT'S ACTIONS: 12D, 12E. Students frequently use writing and other representations of ideas as part of developing their understanding and constructing meaning. Some is reconfiguring information provided. 13D. Some student questions focus on clarification of meaning related to specific concepts. Some address key ideas, their connections and applications and few are procedural. 14D. Some student-student interaction directed toward understanding and applying scientific ideas. Some about procedure. 15C. Students volunteer some examples related to class. 16C, 16D. Most students accept procedures and roles; however, some students express some frustrations with computer activities and station work.
RESOURCES: 17E. Multiple resources are available (library use, computer lab, station materials). 18E. Many resources are used to aid students' understanding and application of ideas. 19D. Access to resources is guided by teacher with some discussion of access with students.
ENVIRONMENT: 20C. Teacher-controlled with some sharing of decision-making with students about use of time. 21B. Some teaching aids displayed unrelated to content. 22A. Few examples of students' work displayed.
OTHER: The simple machine stations were revised based upon student suggestions and teacher observations and continued for two weeks beyond observations.

[a]Number of codes observed in each style. [b]Number corresponds to STAM row (1-22); letter corresponds to teaching style (A-E).

Figure 22. Summary of Video Portfolio - Laura (T5).

the STAM. Laura's summary STAM scores for pre and post observations are located in Table 34 and her numerical averages for the five categories of the STAM matrix are located in Figure 23 (see Appendix K.1 for summary STAM scores and K.2 for average calculations). Chapter III, Stages of STAM analysis describes the method (see Appendix D and J).

Interview analysis.

Interview analysis for Research Question one includes the analysis of the seven questions listed in Table 4 for Teacher Actions. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher Actions can be located in Appendix C.4.

Laura expressed an equally teacher-centered and student-centered Teacher Action (TA) style before and after the PI course. She had several more conceptually focused comments after the course than before the course. Laura took her role as a professional teacher seriously and as such, studied the curriculum and planned student projects to make the material interesting. She viewed time limits, lack of technology access, and federal mandates (No Child Left Behind) as constraints to meeting students' needs. Laura did not feel comfortable leaving concepts once they had been taught; she took time periodically to revisit previously studied material to refresh students' memories. Student emotional confidence was important to Laura who attempted to make personal connections with students and was exhibited in part by allowing students autonomy to move in the classroom as needed.

After participation in the PI course, she made several student-centered comments using terminology that were discussed as part of the course. She felt it was important for

Table 34. STAM Summary Scores - Laura (T5).

	1A Didactic	2B Transitional	3C Conceptual	4D Early Constructivist	5E Experienced Constructivist
Content - C; Rows 1-4 Summary: Pre= 4/5 Post= 4					
1				■ ●	
2				■ ●	■
3				■ ●	
4				■ ●	■
Teacher's Actions - TA; Rows 5-11 Summary: Pre= 4/5 Post= 4/5					
5					■ ●
6			●	■ ●	
7				■ ●	■
8				■	■ ●
9				■	■ ●
10				■ ●	■
11					■ ●
Student's Actions - SA; Rows 12-16 Summary: Pre= 4/5 Post= 3/4					
12				■ ●	●
13				●	■
14				●	■
15			●		■
16			■ ●	●	
Resources - R; Rows 17-19 Summary: Pre= 3/4 Post= 4/5					
17				■	●
18				■	●
19			■	■ ●	
Environment - E; Rows 20-22 Summary: Pre= 3 Post = 2					
20			■ ●		
21		■ ●			
22	●			■	
Total STAM Summary: ■ Pre-Observations = 4.2 ● Post-Observations = 3.9					

Notes: Summary values written with slash indicate score wobbles within range. Teaching styles (A-E) were coded with numbers (1-5) for the purpose of calculating a numerical average displayed in Figure 23.

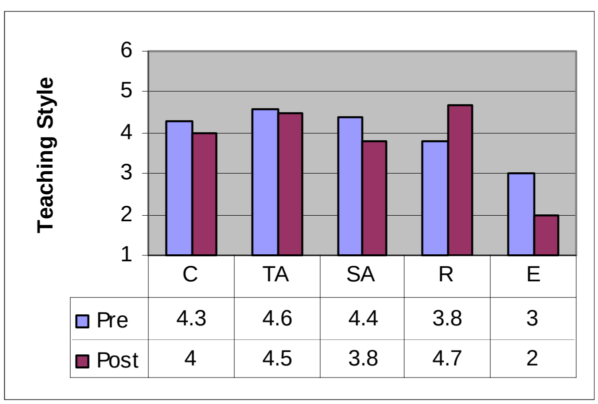


Figure 23. Laura's Summary STAM Scores.

students to learn content and skills as "they are constructing their own learning and knowledge." She also felt that her classroom described as, "experiential, constructivist, and guided-inquiry," was conducive to the needs of diverse students including resource and emotionally disturbed students. Her response to accommodating students with special needs incorporated patience, pairing students with other students who could explain things on a "kid level," and positive reinforcement. Laura's pre-average for Teacher Action style wobbled between transitional and conceptual at 2.5 and her post-average was conceptual at 3.0. Teacher Action excerpts are located in Table 35.

SIDESTEP analysis.

Laura stated that she addressed gender equity issues by assigning tasks equally during collaborative constructive endeavors. She monitored students to observe hierarchies that developed and tried to guide students toward balance. She addressed "special needs" students (hearing-impaired and resource) by using slower speech, abbreviated assignments, and longer processing time. Laura incorporated the use of the system-wide adopted textbook as a resource for science instruction. She reported the use of group work, worksheets, discussions, essays, projects, concept maps, student-developed protocols, and observation checklists before and after the PI class. She incorporated reflection journals after PI participation. Her top three goals for students' learning in science include: demonstrate concept and describe in own words orally; describe in writing in own words or with own terminology; and describe in writing using appropriate terminology.

Table 35. TPPI Interview Codes and Transcript Statements for Laura (T5) Pre and Post - Question One.

	3 Categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Context (25)	Student Diversity (38)
A	Pre: "I am extremely anal and I take the curriculum, study it and make sure I understand exactly what I'm supposed to teach." (18) Pre: "Time limits in terms of class period are a constraint to spending time on what students really need." (23) *Post: "What we're running into is we have technology in the building but we have control issues that prevent being able to get use of the technology and that makes it really tough." (23)*	Pre: "I take the curriculum seriously. A professional is supposed to use the curriculum." (25)	
B	Pre: "What cool project could we do to cram a whole bunch of this into one thing?" (18) Pre: "Like for this project, when they are finished with the brochure we move on." (19) *Post: "I don't know if I'm ever confident, 100%, moving from one concept to another." (19)*		
C	Pre: "When you've got the federal government saying no child left behind means they need to answer these certain questions, and you've got children that read on the 3rd grade level then, how can you not leave them behind?"(23) *Post: "And so we revisit things periodically in order to refresh that in their brains. And I told the kids, this helps you remember, this helps you actually learn it." (19)*		*Post: "Well there are different special needs (resource, behavior issues, hearing impaired, etc.) which means being very patient, explaining things many more times, pairing them up with kids who can explain to them on a kid level, and positive reinforcement." (38)*

Table 35. Continued.

	3 Categories of Teacher Actions		
Style	Teacher Actions (18, 19, 23, 24, 33)	Style	Teacher Actions (18, 19, 23, 24, 33)
D	Pre: "When the children are happy to be in the classroom, are having a good time, then not only are they going to make an emotional connection with the information but they are also going to feel good about themselves." (24) Pre: "I don't care if they are hanging from the ceiling, I don't care if they are running around the room as long as they are not hurting each other. They can put tables wherever they want, they can stand up, sit down, or sit on the floor." (33)		
E	Pre: "So when they are not afraid of it, when they sit down to take the test, then they have confidence and they don't have as much fear." (24) *Post: "So I take the curriculum and try to form activities that will incorporate curriculum as well as experiential learning to get at the curriculum. So that they're not just getting content. They are getting skills and they are constructing their own learning and knowledge." (18)*		*Post: "Well the whole experiential, constructivist, guided inquiry method is really conducive. My whole classroom is a giant modification and it modifies for pretty much every kid. I mean they typically put resource and emotionally disturbed kids in my classroom because it's so conducive to their purpose and it really makes them comfortable in here" (38)*

Note: Question 38 was skipped in pre-interview

Summary of Laura's results for research question one.

STAM analysis revealed that Laura primarily exhibited early and experienced constructivist behaviors during pre and post observations with total STAM summary averages of 4.2 and 3.9 respectively. Her summary STAM averages: decreased from an average between early and experienced constructivist to an average of early constructivist for Content; remained at the early/experienced constructivist level for Teacher Actions; decreased from early/experienced constructivist to conceptual/early constructivist for Student actions; increased from conceptual/early constructivist to early/experienced constructivist for Resources; and decreased from conceptual to transitional for Environment.

Analysis of Laura's TPPI interview questions (beliefs) revealed that her pre average for Teacher Actions wobbled between transitional and conceptual. Laura's behaviors were more student-centered than her beliefs for Teacher Actions. She cited time limits (not having block schedule) and lack of access to technology as constraints to teaching science.

III. Research Question Two Analysis

> "Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?"

Interview analysis.

Interview analysis for Research Question two includes the analysis of the ten questions listed in Table 4 for Student Actions and Teacher's Philosophy of Teaching. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average

calculations for Student Actions and Teacher's Philosophy of Teaching can be located in Appendix C.4.

Laura expressed primarily a conceptual to student-centered style for Student Actions (SA) prior to and at the completion of the PI course. She believed students learn best when they are actively involved and they can use different skills that they have developed over time. Laura asked students to demonstrate understanding by applying learning to a new situation and completing tests. She believed students valued their educational experience in her classroom because they got to experience many things. Laura's pre and post SA averages wobbled between conceptual and early constructivist styles with an average of 3.2. SA excerpts for Laura are located in Table 36.

Laura's Philosophy of Teaching (PT) was student-centered prior to and at the completion of the PI course. She described her teaching as constructivist and problem-centered with the use of guided inquiry. She felt that there are a wide range of characteristics of "good learners." "It depends on what kind of learners they are before I could describe what the characteristics are." She felt that students knew she valued them as individuals and that they would take an excitement and confidence for learning from her class. "In the process of enjoying themselves, they might have accidentally learned something that they can use." Her most valuable learning experience as a classroom teacher was that it's appropriate to adjust the schedule to meet the needs of students. Laura's greatest strengths were creativity, flexibility, and reflective practice. She wanted to improve her patience level and her ability to communicate her expectations to students without frustrating them. Her pre and post PT averages wobbled between early and

Table 36. TPPI Interview Codes and Transcript Statements for Laura (T5) Pre and Post - Question Two.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
A	Pre: "Then I took the test out of the book and presented it to them and nobody failed it." (30)			
B				
C	Pre: "I believe my students learn best when they are actively involved." (29) Pre: "It's like a performance assessment type of thing. You sit down with them and you know as they are going how they are doing." (30) Pre: " I ask them. When they are able to show me, when I look at their work." (30) Pre: "When they can use their knowledge and apply it in a situation." (30)			

Table 36. Continued.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
D	Pre: "Get a creative process going and avoid a linear path of learning, go more lateral, to deal with more of a web, you know, where they are able to use different skills that they have and develop different skills at the same time that they are learning." (29)	Pre: "I believe students would say they liked my class because, 'we got to do, we got to do, we got to do'." (37)	Pre: "I think most of them know that I value them as a person, and I think they'll take a little bit more of an excitement and confidence for learning." (20) *Post: "I think that it's valuable to them that at some point during the year, the light bulb comes on and they are having a good time and that in the process of enjoying themselves then they might have accidentally learned something that they can use and when they feel good about it that makes knowledge more tasty to them and it makes them happier people." (20)* Pre: "I'm working on a style of a combination of William Glasser's quality schools and the inquiry method as much as possible." (22)	Pre: "Creativity is probably my biggest strength. I like to think I'm flexible and adapt in the midst of an opportunity. I think people call them teachable moments." (39) Pre: "I think that as I get older that I don't have as much patience as I had when I first started teaching." (40) Pre: "Sometimes the kids tell me my expectations are too high. And so, I'm taking a look at that and I'm trying to determine if maybe the way I communicate my expectations needs to change. Because I don't think the expectations are too high, I think maybe I'm not communicating them clearly enough on a level that they feel comfortable with." (40)

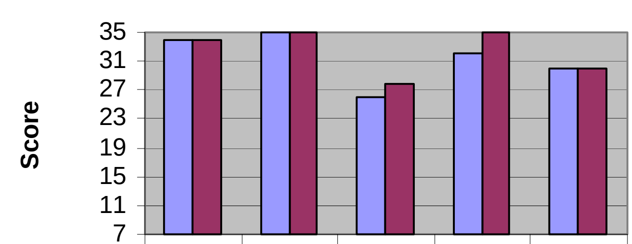
Table 36. Continued.

	Student Actions (2 categories)		Philosophy of Teaching (2 categories)	
Style	Student Actions (29, 30)	Environment (37)	Philosophy of Teaching (1, 13, 20, 21, 22)	Self as Teacher (39, 40)
E			Pre: "The constructivist theory and problem-oriented learning is apparently the way I teach." (1) *Post: "I really think I use more guided inquiry than pure inquiry." (1)* Pre: "There's an awfully wide range of characteristics of good learners. It depends on what kind of learner they are before I could describe what the characteristics are." (13) Pre: "I learned at some point that it was OK to adapt the time schedule to the kids needs and not worry so much about stuffing the curriculum down their throats." (21) Pre: "I'm constantly reassessing did I do the right thing, am I doing well at this, are the kids learning? Was that the best experience that they could have had? I'm always reassessing to see if I met everyone's needs." (21)	*Post: "I really am introspective and I reflect, very often, on what is going on in my classroom and the interactions that I have with my kids and their responses, both affective and academic, so I can come back and improve things." (39)* *Post: "One thing that I have changed because of the group that I have this year is I've learned more how to approach the kids, get them to tell me how they need me to say it and how they need to hear it as I'm giving them my expectations or as I'm introducing an activity." (40)*

experienced constructivist with averages of 4.4 and 4.6 respectively. PT excerpts for Laura are located in Table 36.

Constructivist Learning Environment Survey - CLES analysis.

Laura's CLES scores are exhibited in Figure 24 (see Appendix F.3 for calculations). Her pre (34) and post (34) Personal Relevance scores were in the high agreement range which indicated that she placed a high emphasis on linking school science with students' everyday experiences. Her pre (35) and post (35) Critical Voice scores were both in the high agreement range which indicated that she placed a high emphasis on encouraging students to question her plans and methods and express concerns about impediments to their learning. Her pre (26) and post (28) Shared Control scores increased slightly from a high intermediate to a high agreement range. This indicates that after the PI course the teacher placed more emphasis on inviting students to: participate in designing their own learning activities; determine assessment criteria; and negotiate the norms of the classroom. Her pre (32) and post (35) Student Negotiation scores were both in the high agreement range which indicated that she placed a high



	PR	CV	SC	SN	AT
Pre	34	35	26	32	30
Post	34	35	28	35	30

Figure 24. Laura's CLES Scores.

emphasis on providing opportunities for students to: explain their ideas to other students; make sense of other students' ideas; and reflect on the viability of their own ideas. Her pre (30) and post (30) Attitude Scale scores were also in the high agreement range which indicated that she felt students: anticipated the activities within her classroom; found the activities worthwhile; and understood and enjoyed the activities.

Science Teaching Efficacy Belief Instrument - STEBI analysis.

Laura's Personal Science Teaching Efficacy Belief subscale scores for the pre and post assessments were both 62 points (max=65 points). Therefore, with a score towards the upper range of the high efficacy category, she was highly comfortable with her ability to teach science. Her Outcome Expectancy (OE) subscale scores for the pre and post assessments decreased notably from 46 (high OE) to 37 (average OE) points (max=60 points), indicating that she had less confidence in her teaching ability to create desirable outcomes (see Appendix G.2 for calculations).

Reflective journal questions.

Laura described how she planned to incorporate several of the ideas from reading the assigned PI course textbook to her own classroom (Excerpt A and B). Excerpt A describes how she agreed that inquiry should not be used to teach every lesson and excerpt B describes how she plans to start with developing inquiry abilities (for students) at the beginning of the school year and develop the students' abilities to design open/full inquiries by the end of the school year. Excerpt C describes how a teacher's lack of content knowledge can be a hindrance to comfort-level in delivering inquiry-based lessons. Excerpt D describes the challenges of designing motivational inquiry-based

experiences for students and developing a classroom atmosphere conducive to group activities.

Excerpt A (5/5/03) "I began reading the text yesterday. I appreciated the point made that every area of the science curriculum may not lend itself to inquiry strategies, and even if it did, the kids would get bored with it and then the effectiveness would decrease dramatically."

Excerpt B (6/1/03) "I can see how I would like to organize my syllabus for next year. I want to structure the learning strategies in my classroom so that the children start by gaining basic inquiry investigation skills in the context of constructing content knowledge, and then build up to full independent inquiry investigations by the end of the school year. I think I will try to have them keep a reflection journal of sorts to track their responses to their learning as we go. I would like for it to include examples of each inquiry 'ability' (as designated in the NSES Science Content Standards) so that they will have a road map to refer to. A little metacognition goes a long way."

Excerpt C (6/1/03) "I can see how my perspective of this has changed over the years. At first glance, it seemed it was easier to do pure inquiry with the children when I knew fewer 'answers' than I do now! However, now I have the advantage of experience with the children and understanding of the age group I am working with so that I am better able to provide questions to stimulate them forward. And I find I am more deeply stimulated to further my learning so that I am better able to help the kids. Though I was never really intimidated by the fact that I didn't have all of the answers, I was concerned at times that I wouldn't be able to give the children as full a comprehension as they could have."

Excerpt D (6/19/03) "I am struggling to find a way to set up situations which will allow kids to truly pursue inquiry. I want them to be able to have time to get motivated about their investigation, really plan, design, set up, etc. I want them fully immersed and I am only there as an assistant, materials procurement person, and co-investigator. I want to work with the kids so that by the time we do a true inquiry, they have comfortable, successful group interactions that won't interfere with their investigations too much."

Summary of Laura's results for research question two.

TPPI analysis of Laura's pre and post Student Actions revealed that she held beliefs between conceptual and early constructivist. Her pre and post Philosophy of Teaching revealed scores between early and experienced constructivist. Her Student Action behaviors, described in Section II, were between early and experienced

constructivist for the pre observation and between conceptual and early constructivist for post observations. The primary reason given for a change in behaviors for Student Actions from pre to post observations was that her students (during the post-observations) were not as prepared emotionally or academically for a constructivist-style of teaching. She was working toward a constructivist style with them and planning to implement more experienced constructivist-type behaviors as the year progressed.

Laura's pre and post CLES scores for all subscales were in the high intermediate to high agreement range which indicated that she believed she implemented constructivist behaviors. She believed her students liked her class because they got to do things. During her pre-interview she stated that she learned to adjust her teaching plans to meet the needs of students rather than "stuff the curriculum down their throats" and that she believed that she taught with a constructivist theory, problem-oriented approach.

Laura felt highly confident in her ability to teach science, as revealed by her pre and post STEBI, Personal Science Teaching Efficacy Belief Scale scores. However, her beliefs in her ability to create desirable outcomes decreased from pre to post assessment as measured by the STEBI, Outcome Expectancy scales. Based upon journal responses (over the summer, 2003), Laura was making plans for how she would scaffold inquiry skills into the classroom for her next group of students. However, she was basing these plans on the group of students she had the previous school year. As mentioned, her student group for the post-observation year was not as prepared emotionally or conceptually as her previous group, so this can account for her decrease in her confidence of creating positive outcomes through her science teaching.

IV. Research Question Three Analysis

"Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?"

Interview analysis.

Interview analysis for Research Question three includes the analysis of the three questions listed in Table 4 for Teacher and Content. Chapter III, levels of TPPI analysis describes the process of analysis. Numerical average calculations for Teacher and Content can be located in Appendix C.4. Interview question 18, "How would you define inquiry?" and 19, "Describe an experience you have had learning/teaching by inquiry?" were analyzed by comparing the response given by the participant to the definition provided for guided, open, and structured inquiry and activity provided in Chapter II (Description of Inquiry).

Laura expressed teacher-centered to conceptual to student-centered styles for Teacher and Content (TC) prior to and at the completion of the PI course. She viewed science as making sense of the world around us. Science was valuable to Laura because of the ability to question and experience original thought. She believed that students should have a working knowledge of the world and be able to apply science process skills. Laura's pre and post TC averages of 2.2 wobbled between transitional and conceptual. Laura's TC excerpts can be located in Table 37.

When asked to define inquiry she described open/full inquiry during her pre-interview (Excerpt A). When asked to describe an experience learning by inquiry she described a guided inquiry experience obtained during a workshop (Excerpt B). She described an experience teaching using guided inquiry before her exposure to the PI

Table 37. TPPI Interview Codes and Transcript Statements for Laura (T5) Pre and Post - Question Three.

Style	Teacher and Content (14, 28, 34)
A	Pre: "Science is making sense of the things we observe around us." (14)
B	Pre: "When they experience that question, they are experiencing the wonder of original thought and that is the most beautiful thing that could happen for a human being except for giving birth, maybe." (28)
C	Pre: "As far as science concepts, I try to give the kids a working knowledge of their world that they might not already have. I mean I try to give the scientific stuff but also how does it apply to them." (34)
D	Pre: "Analysis and problem solving skills are important." (34)

course (Excerpt C). She credited the PI course with helping her learn about the frustration as well as the questioning skills that are inherent to authentic inquiry-based learning (Excerpt D).

Excerpt A - 3/12/03 (Pre-interview) "Pure inquiry is to have an unknown situation and propose your own question about it and determine your own investigation and investigate it on your own and come up with your own answers and evaluate your own answers and pass judgment on your own answers and then reevaluate and go at it again. To me that's the purest of inquiry and occasionally you can do that in the classroom."

Excerpt B - 3/12/03 (Pre-interview) "The most fun that I had and I don't know if it was a, to me it wasn't an inquiry, now that that I reflect on it, but they called it inquiry. It was a workshop that I went to …. they gave us a big wad of stuff and said make a top. And they called that inquiry. Well to me that's problem-based learning, where you know, that's more synthesis-type oriented thought where you have a bunch of pieces and they say create something out of these pieces, and yah it's inquiry because you're thinking about how can this piece work with that piece and how can we make this work together. So to me that's a form of inquiry, but it's more of a problem-based learning.

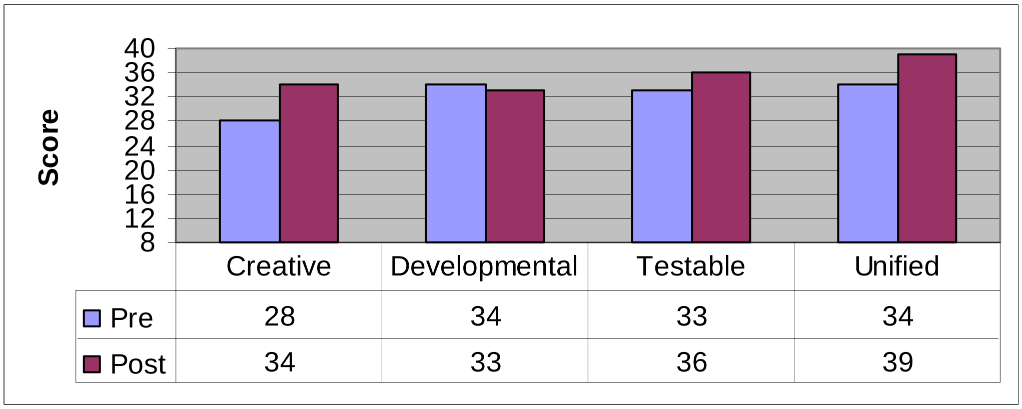
Excerpt C - 3/12/03 (Pre-interview) "Probably the closest that I can think of, that I've ever tried to setup an inquiry … It seems like when we did magnetism I got out some magnets and I had baggies full of iron filings and baggies full of sawdust and baggies full of different materials on the table and I had all of this stuff just in a pile and uh, and then when the kids came in I said I'm not ready to start class I want you guys to just, don't open the bags, but you can play with it. Because really with inquiry with any

contamination in my mind, any kind of setup, you just don't want to contaminate it if at all possible. You don't want to give them any ideas of what they are supposed to think or supposed to find. But those are the things that come to mind."

Excerpt D - 11/25/03 (Post-interview) "I learned a lot about frustration, which it had been a while since I had experienced that in a group setting. I'm very accustomed to frustration by myself and doing an inquiry situation alone and then being able to call somebody up and say, Ok, I've got a problem here, what do you suggest? And then, the typical thing is that you get suggestions for fixing the problem, whereas in this situation it was, you know, your question gets answered with a question, which is standard procedure in inquiry, you know, in an inquiry classroom, and very frustrating. But that's what you want. The whole point with frustration is that when you get to that peak of frustration is when you are on the verge of not self-discovery but discovering the answer for yourself and that's the whole point of uncovering the truth and actually learning something. Obviously the person who is leading or guiding or presenting the inquiry, you know, has already set it up and they may or may not have all the answers but they have a general idea of what to expect, but you don't want to give that to your students. You want them to gain the knowledge on their own, so that's the frustration that you want. And I learned a lot about questioning. Dr. Hickok is a superb questioner, not to mention, I tell you, he's got a lot of patience. I was so impressed, he taught me a lot about that and I've tried to model that. He modeled excellent questioning, and turning questions, I learned about that at TSTA but I've, in reflecting on that workshop, I was thinking that's what he did. He was really good at turning questions, at taking the question that somebody asked and saying well if you asked it this way where would it take you and I was so impressed because he could do that right off the top of his head and it could have been because he was familiar with the material but it could have been also from experience. And that's something that I've been very conscious of trying to do in my classroom because of that experience this summer. Gosh, I really did learn a lot."

Modified Nature of Scientific Knowledge Survey - MNSKS analysis.

Laura's MNSKS subscale scores, Figure 25, were within the accepted view of the Nature of Science (above 24; see Appendix H.2 for calculations). Her Creative and Unified subscale scores increased notably, six and five points respectively. Her Developmental and Testable subscale scores did not change noticeably with a decrease of 1 point and an increase of 3 points respectively. Laura's Total MNSKS Scale Scores increased noticeably form pre to post assessment (129-142 points).



Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 25. Laura's MNSKS Scores.

Constructivist Learning Environment Survey - CLES analysis.

Laura's pre (29) and post (29) Scientific Uncertainty Scale scores were in the range of "often" to always." This indicates that Laura placed a high emphasis on providing opportunities for students to learn that scientific knowledge is: evolving and provisional; shaped by social and cultural influences; and arises from human interests and values (see Appendix F.3 for calculations).

Reflective journal questions.

Laura expressed a concern with how school science is structured in a way that does not let students experience authentic science. In particular she expressed that school science often does not provide students with the time and support to develop and pursue their own questions.

6/19/03 "Working in the lab is very stimulating. I find I have many questions running through my mind and so very little time to pursue any of them. That is the point at which I feel most like I perceive students in public school science labs must feel when they are in the typical, contrived lab activities. I understand that we are in a time constrained situation with the course, that's not what I'm referring to. It's the sensation of

desiring to investigate further and not having the opportunity to do so that is most frustrating for me at this point - not the frustration of the investigation itself."

Summary of Laura's results for research question three.

Analysis of Laura's pre and post Teacher and Content beliefs revealed teacher-centered scores ranging between transitional and conceptual. Her MNSKS subscale scores were all in the range of the accepted view of the NOS. Her Creative subscale score increased six points following PI participation, while her scores on the other three scales did not change notably. Her CLES Scientific Uncertainty pre and post scores remained in the range of "often to always." In a journal reflection that was written regarding the time constraints in the lab of the PI course, she commented that school science often does not offer opportunities for students to experience authentic science because they are not given the time to create and pursue their own questions.

Laura had an understanding of the definition of open/full inquiry prior to PI participation. She could distinguish between problem-solving activities and guided or open inquiries. She credited her experiences in the PI course with providing an opportunity to experience the frustration her students feel as learners and to observe advanced questioning skills as modeled by Dr. Hickok.

V. Research Question Four Analysis

> "Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?"

Mentoring Efficacy Questionnaire - MEQ analysis.

Laura's pre MEQ score of 66 (out of 100) points increased to a post-score of 75 points (see Appendix I.2 for calculations), both within the high intermediate efficacy range. She indicated that she was uncertain if she was confident in helping a protégé implement inquiry-based science instruction prior to the Project INQUIRE course (Question 20); however, after the course she indicated that she was confident in her ability to mentor protégé's in this type of instruction.

Prior to and at the completion of the PI course, Laura indicated her greatest strength as a science mentor as "having experimented with inquiry and constructivist theory in the classroom and feeling fairly comfortable using both. I have strong content knowledge and depth of curriculum perspective." Her greatest challenge before and after the course was "working with established teachers who are set in their ways."

Reflective journal questions.

Laura described situations in which she had shared her lesson strategies with other teachers at her grade level.

9/25/03 "I have been sharing my ideas with two of the other 6th grade science teachers. They have overall been receptive and willing to try implementing some of the inquiry-based lessons that I have shared. The newer teacher of the two has even come to observe me as I teach."

Summary of Laura's results for question four.

Laura's Mentoring Efficacy Questionnaire scores increased following PI participation. She indicated she was uncertain in helping a protégé implement inquiry-based instruction prior to PI participation; however, she was confident after the course. She felt that she could contribute a knowledge of content, curriculum, and constructivist

theory and share experiences with teaching and learning with inquiry. She cited teacher resistance to change as a challenge to mentoring other teachers.

VI. Participant Summary

Table 38 is a data matrix for Laura that provides an overall picture of her results for the Project INQUIRE assessments. Laura's beliefs were less student-centered than her actions in the area of Teacher Actions. Her Student Action and Philosophy of Teaching beliefs were highly student-centered as measured by the TPPI interview questions and the CLES instrument. Her Student Action behaviors as measured by the STAM instrument became slightly less constructivist than her beliefs during her post observations due to a difference in the capabilities of the students (less capable then those in pre observations), which corresponded with a decrease in her self-reported STEBI, Outcome Expectancy. She felt highly confident in her abilities to teach science as measured by the STEBI, Personal Science Teaching Efficacy Belief Scale scores.

Laura held high understandings of the scientific inquiry and NOS aspects of scientific literacy prior to PI participation. She demonstrated an understanding of inquiry-based instruction during pre and post observations and through her interview responses. She credited the PI course for providing incites into how her students feel as learners (frustration) and advancing her skills to moderate inquiry-based instruction through questioning. Her perceived efficacy toward mentoring other colleagues to use inquiry-based instruction increased after course participation. She felt she could offer mentees an experienced account of constructivist-style teaching. She was concerned about helping teachers who might be resistant to change.

Table 38. Project INQUIRE Data Matrix - Laura (T5).

<table>
<tr><td colspan="11">Teacher Information: 6th grade physical science; 13 years teaching experience</td></tr>
<tr><td colspan="11">Question One: Do teachers who complete Project INQUIRE change their instructional practices?</td></tr>
<tr><td rowspan="3">STAM[a] Averages
T=Teacher
S=Student</td><td colspan="2">Content</td><td colspan="2">T. actions</td><td colspan="2">S. actions</td><td colspan="2">Resources</td><td colspan="2">Environment</td></tr>
<tr><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td><td>Pre</td><td>Post</td></tr>
<tr><td>4.3</td><td>4</td><td>4.6</td><td>4.5</td><td>4.4</td><td>3.8</td><td>3.8</td><td>4.7</td><td>3</td><td>2</td></tr>
<tr><td>Total STAM Summary</td><td colspan="5">Pre: 4.2 Early Constructivist</td><td colspan="5">Post: 3.9 close to Early Constructivist</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.5</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 3.0</td><td colspan="6">Conceptual</td></tr>
<tr><td colspan="11">Question Two: Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction?</td></tr>
<tr><td rowspan="2">TPPI[a] - Student Actions</td><td colspan="2">Pre</td><td colspan="2">Avg.: 3.2</td><td colspan="6">Conceptual/Early Constructivist</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 3.2</td><td colspan="6">Conceptual/Early Constructivist</td></tr>
<tr><td rowspan="2">TPPI[a] - Philosophy of Teaching</td><td colspan="2">Pre</td><td colspan="2">Avg.: 4.4</td><td colspan="6">Early/Experienced Constructivist</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 4.6</td><td colspan="6">Early/Experienced Constructivist</td></tr>
<tr><td rowspan="6">CLES -
Personal Relevance
Critical Voice
Shared Control
Student Negotiation
Attitude</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="6"><u>Scores</u>:
7-13 = Low
14-20 = Low Intermediate
21-27 = High Intermediate
28-35 = High</td></tr>
<tr><td colspan="2">34</td><td colspan="2">34</td></tr>
<tr><td colspan="2">35</td><td colspan="2">35</td></tr>
<tr><td colspan="2">26</td><td colspan="2">28</td></tr>
<tr><td colspan="2">32</td><td colspan="2">35</td></tr>
<tr><td colspan="2">30</td><td colspan="2">30</td></tr>
<tr><td rowspan="3">STEBI -
Personal efficacy-PE
Outcome expectancy-OE*</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="3"><u>PE Scores</u>: 13-30 = Low; 31-48 = Average; 49-65 = High efficacy
<u>OE Scores</u>: 12-28 = Low; 29-44 = Average; 45-60 = High expectancy</td></tr>
<tr><td colspan="2">62</td><td colspan="2">62</td></tr>
<tr><td colspan="2">46</td><td colspan="2">37</td></tr>
<tr><td colspan="11">Questions Three: Do teachers who complete Project INQUIRE change their understanding of scientific literacy?</td></tr>
<tr><td rowspan="2">TPPI[a] - Teacher and Content</td><td colspan="2">Pre</td><td colspan="2">Avg.: 2.2</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td colspan="2">Post</td><td colspan="2">Avg.: 2.2</td><td colspan="6">Transitional/Conceptual</td></tr>
<tr><td rowspan="6">MNSKS:
Creative*
Developmental
Testable
Unified*
Total</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="6"><u>Scores</u>:
8-23 = Unaccepted view (32-95 - Total)
24 = Neutral view (96 - Total)
25-40 = Accepted view (97-160 - Total)</td></tr>
<tr><td colspan="2">28</td><td colspan="2">34</td></tr>
<tr><td colspan="2">34</td><td colspan="2">33</td></tr>
<tr><td colspan="2">33</td><td colspan="2">36</td></tr>
<tr><td colspan="2">34</td><td colspan="2">39</td></tr>
<tr><td colspan="2">129</td><td colspan="2">142</td></tr>
<tr><td>CLES - Scientific Uncertainty</td><td colspan="2">Pre: 29</td><td colspan="2">Post: 29</td><td colspan="6">See Scale Scores in question two.</td></tr>
<tr><td rowspan="2">Inquiry - Definition and Experience Teaching (T) or Learning (L)</td><td colspan="2">Definition Pre</td><td colspan="2">Experience Pre (T) & (L)</td><td colspan="3">Definition Post</td><td colspan="3">Experience Post</td></tr>
<tr><td colspan="2">Guided and open</td><td colspan="2">Guided</td><td colspan="3">Guided and open</td><td colspan="3">(T) - Guided
(L) - Open</td></tr>
<tr><td colspan="11">Question Four: Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues?</td></tr>
<tr><td rowspan="3">Mentoring Efficacy
Total*
Question #20[b] *</td><td colspan="2">Pre</td><td colspan="2">Post</td><td colspan="6" rowspan="3"><u>Scores</u>:
20-40 = Low; 41-60 = Low Intermediate; 61-80 = High Intermediate; 81-100 = High</td></tr>
<tr><td colspan="2">66</td><td colspan="2">75</td></tr>
<tr><td colspan="2">Uncertain</td><td colspan="2">Agreed</td></tr>
</table>

Note: *=notable change. [a]TPPI & STAM scale: 1=Didactic, 2=Transitional, 3=Conceptual, 4=Early Constructivist, 5=Experienced Constructivist. [b]Did participant rate self as confident in ability to mentor protégé with inquiry-based instruction?

Cross-Case Study Analyses

Introduction

The cross-case analysis is divided into five sections. The first four sections are based upon the four research questions. The fifth section describes themes developed from the interview transcripts and reflective journal entries. The STAM instrument results were disaggregated into Teacher Actions, Student Actions, and Content to compare behaviors to corresponding beliefs as measured by the TPPI questions.

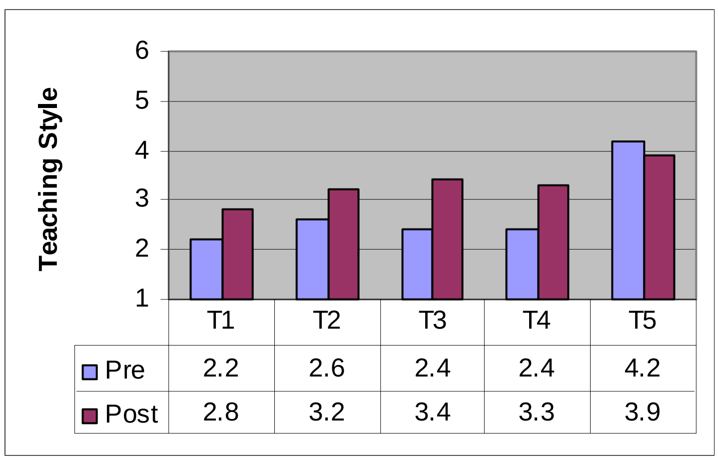
Participants' pre and post total STAM summary averages were compared for research question one. The STAM instrument and the TPPI questions for Teacher Actions were compared to examine changes in instructional practices. Changes in participants' assessment practices from the SIDESTEP instrument are also examined for question one. For question two, a number of instruments were used to compare changes in teacher's attitudes and beliefs including: the STAM instrument and TPPI questions comparing Student Actions; TPPI questions for Philosophy of Teaching; five CLES subscales (Personal Relevance, Critical Voice, Shared Control, Student Negotiation, and Attitude Scale); and the STEBI subscales. For question three, a number of measures were used to compare changes in teacher's understandings of scientific literacy including: the STAM instrument and TPPI questions comparing Teacher and Content; the Scientific Uncertainty subscale of the CLES; the MNSKS subscales and total scale scores; and participants' definitions of inquiry. The Mentoring Efficacy Questionnaire (MEQ) results were examined for question four. Notable changes in participant's views as described in Chapter III were: four or more points on the subscales of the CLES, STEBI, and

MNSKS instruments; 16 or more points on the MNSKS total scale; and 10 points on the MEQ.

Question One: Change Their Instructional Practices?

Comparison of Total STAM Summary Averages

The teachers generally displayed more constructivist behaviors after PI course participation than before. Four of the teachers (T1-T4) displayed behaviors within the transitional/conceptual range prior to the course. While T1 exhibited a more conceptual teaching style after the course, T2-T4 changed their practices to within the conceptual/early constructivist range. T5 displayed student-centered behaviors before and after the course with a slight decrease in her average. Figure 26 displays a comparison of the total STAM summaries for all five participants.

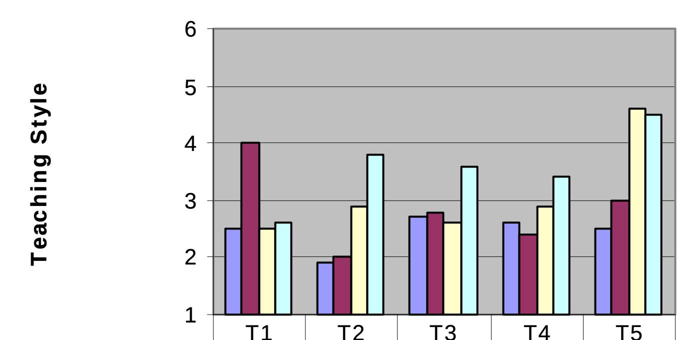


Note: 1=Didactic; 2=Transitional; 3=Conceptual; 4= Early Constructivist; 5=Experienced Constructivist; 6=Constructivist Inquiry

Figure 26. Total STAM Summary Comparisons.

TPPI and STAM Comparison of Teacher Actions - TA

Teacher beliefs about their actions, as measured by the TPPI -TA, for four of the five teachers (T2-T5) were generally in the teacher-centered to conceptual range with little change pre to post. Beliefs for T1 (Marie) increased notably from transitional/conceptual to early constructivist. Actions proved to be more conceptual to student-centered than beliefs, as measured by the STAM, for four of the five teachers (T2-T5). T1's behaviors changed minimally from pre to post and were in the transitional to conceptual range. Teachers 2-4 developed more constructivist practices after PI course participation by transitioning from transitional/conceptual to conceptual/early constructivist behaviors. Figure 27 displays the pre and post Teacher Action averages for the TPPI and STAM by participant.



	T1	T2	T3	T4	T5
Pre TPPI	2.5	1.9	2.7	2.6	2.5
Post TPPI	4	2	2.8	2.4	3
Pre STAM	2.5	2.9	2.6	2.9	4.6
Post STAM	2.6	3.8	3.6	3.4	4.5

Note: 1=Didactic; 2=Transitional; 3=Conceptual; 4= Early Constructivist; 5=Experienced Constructivist; 6=Constructivist Inquiry

Figure 27. TPPI and STAM Comparison of Teacher Actions.

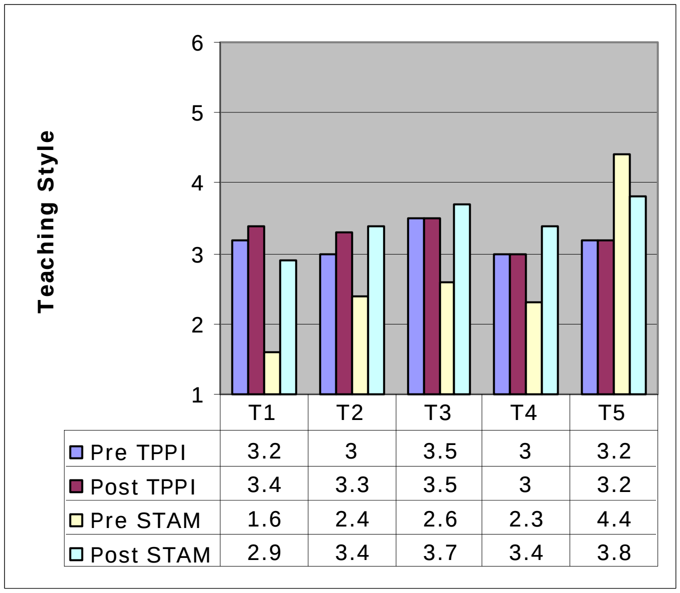
SIDESTEP Analysis

The SIDESTEP revealed that several of the teachers incorporated more inquiry-based assessment styles after participation in the course. Marie did not change her reported assessment strategies, which incorporated traditional and potentially inquiry-based methods, including discussion, projects and portfolios. Tee Jay used discussions, projects, and concept maps prior to participation and added essays, debates, and inquiry to her list of assessment strategies after the course. Daphne used primarily traditional methods of assessment prior to PI participation and incorporated portfolios and concept maps after. Shannon initially used discussions, essays, projects, and oral reports and added concept maps after. Laura initially used discussions, essays, projects, concept maps, student-developed protocols, and observation checklists and added reflection journals after.

Question Two: Change Beliefs and Attitudes of Science Instruction?

TPPI and STAM Comparison of Student Actions

Figure 28 displays the pre and post Student Action averages for the TPPI and STAM by participant. Student Action beliefs, as measured by the TPPI, changed minimally for one teacher (T2 - Tee Jay) and remained the same for the other four teachers. All five teachers held beliefs within the conceptual or conceptual/early constructivist range. Teachers 1-4 changed their Student Action behaviors to become more similar to their beliefs, as measured by the STAM, from teacher-centered toward conceptual or student centered behaviors (T1: conceptual; T2 - 4: conceptual/early constructivist). T5 (Laura) had student-centered behavior (higher than her beliefs) pre and post; however she



	T1	T2	T3	T4	T5
Pre TPPI	3.2	3	3.5	3	3.2
Post TPPI	3.4	3.3	3.5	3	3.2
Pre STAM	1.6	2.4	2.6	2.3	4.4
Post STAM	2.9	3.4	3.7	3.4	3.8

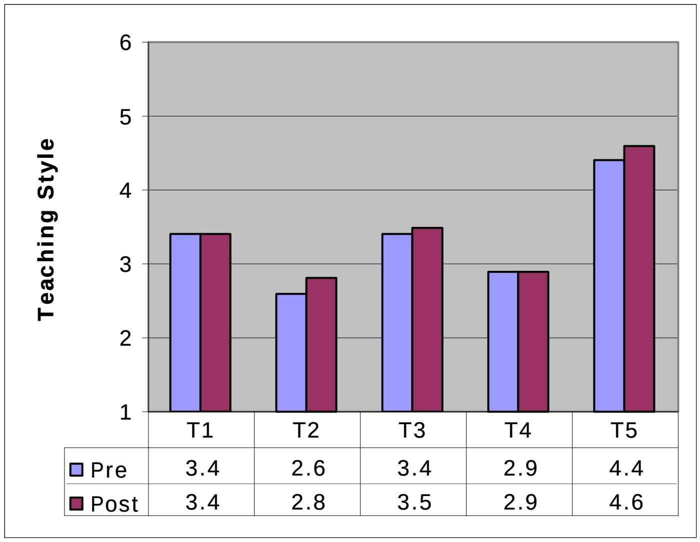
Note: 1=Didactic; 2=Transitional; 3=Conceptual; 4= Early Constructivist; 5=Experienced Constructivist; 6=Constructivist Inquiry

Figure 28. TPPI and STAM Comparison of Student Actions.

exhibited early/experienced constructivist actions before and conceptual/early constructivist actions after the course.

Philosophy of Teaching

All five participants' Philosophy of Teaching beliefs changed minimally pre to post. T1 and T3 held beliefs within the conceptual/early constructivist range. T2 and T4 held beliefs within the transitional/conceptual range (closer to conceptual). T5 held beliefs within the early/experienced constructivist range. Figure 29 displays the pre and post Philosophy of Teaching averages for the TPPI by participant.



Note: 1=Didactic; 2=Transitional; 3=Conceptual; 4= Early Constructivist; 5=Experienced Constructivist; 6=Constructivist Inquiry

Figure 29. TPPI Comparison of Philosophy of Teaching.

Constructivist Learning Environment Survey (CLES)

Figure 30 displays the pre and post Personal Relevance scores by participant. There were relatively small or no changes for all five teachers in the Personal Relevance scale. Teachers 1, 2, and 5 reported a high emphasis on linking school science with students' everyday experiences, while teachers 3 and 4 reported a high intermediate agreement.

There was little change in four of the five teachers' beliefs with respect to the Critical Voice Scale (T1 & T3: high intermediate; T2 & T5: high). T4 (Shannon) changed her views notably (decreased four points) within the high intermediate agreement range. Figure 31 displays the pre and post Critical Voice scores by participant.

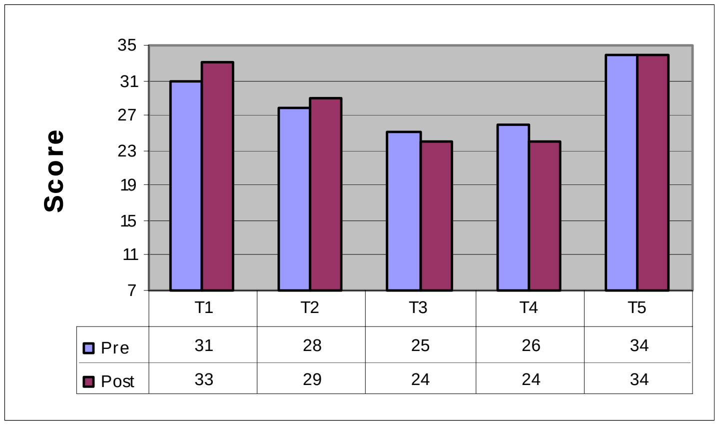


Figure 30. CLES Personal Relevance Scale Comparison.

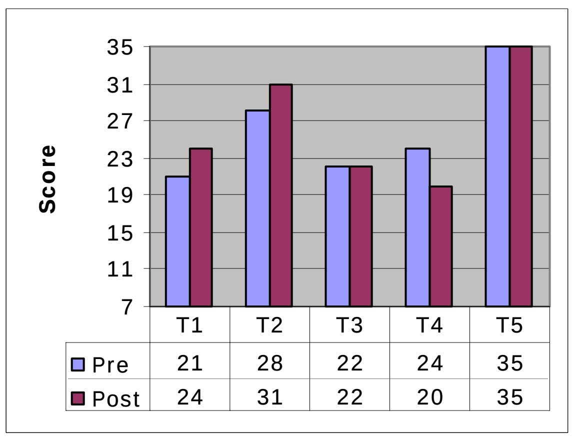


Figure 31. CLES Critical Voice Scale Comparison.

There was little change in three of the five teachers' views of Shared Control (T3: high intermediate; T4: low intermediate; T5: high intermediate to high). T1 (Marie) changed her views notably (increased four points) within the high intermediate agreement range. T2 (Tee Jay) had a relatively large increase (nine points) from a low intermediate to a high agreement with the scale. Figure 32 displays the pre and post Shared Control scores by participant.

There was little change in three of the five teachers' views of Student Negotiation (T3 and T4: high intermediate; T5: high). T1 and T2 increased their scores notably from a high intermediate to a high agreement with student negotiation. Figure 33 displays the pre and post Student Negotiation scores by participant.

There were little changes in four of the five teachers' views of students' attitudes as measured by the Attitude Scale (T1, T2, T5: high; T4: high intermediate). T3 (Daphne) increased her views notably (five points) from a high intermediate to a high agreement with the scale. Figure 34 displays the pre and post Attitude Scale scores by participant.

Science Teaching Efficacy Belief Instrument (STEBI)

T3 (Daphne) changed her personal science teaching efficacy beliefs considerably from low to average efficacy. T4 (Shannon) changed her efficacy beliefs notably within the high efficacy category. There was little change in three of the five teachers' views of Personal Science Teaching Efficacy (T1, T2, T5: high efficacy). Figure 35 displays the pre and post Personal Science Teaching Efficacy Beliefs by participant.

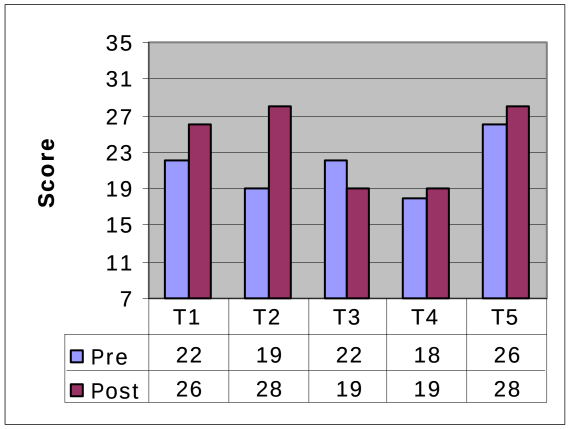


Figure 32. CLES Shared Control Scale Comparison.

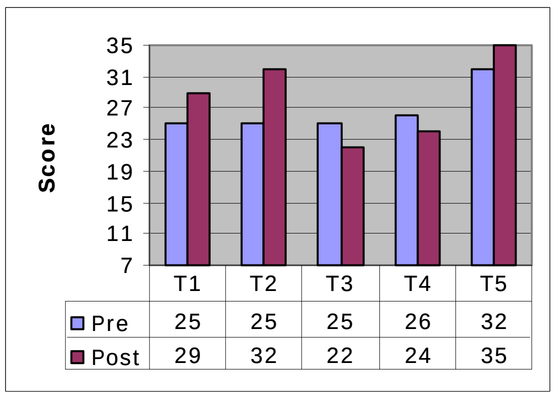


Figure 33. CLES Student Negotiation Scale Comparison.

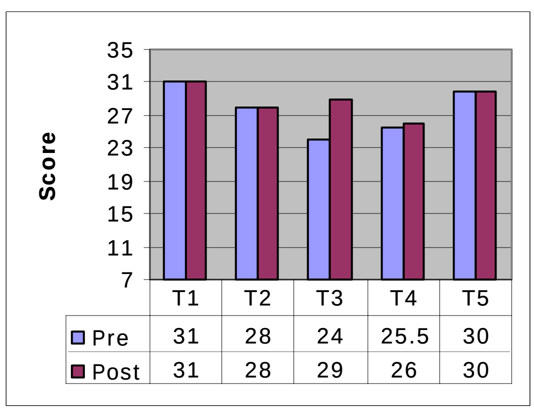


Figure 34. CLES Attitude Scale Comparison.

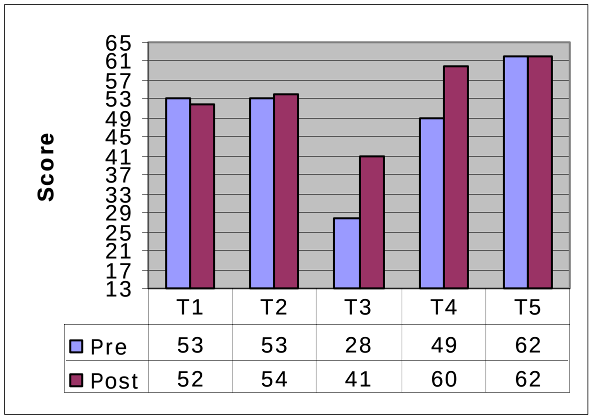


Figure 35. STEBI Personal Science Teaching Efficacy Scale Comparison.

Figure 36 displays the pre and post Outcome Expectancy scores by participant. There were little changes in two of the five teachers' views as measured by the Outcome Expectancy scale (T2: low; T4: high). The outcome expectancy beliefs of T1, T3, and T5 decreased from a high to an average efficacy range.

Question Three: Change Their Understanding of Scientific Literacy?

TPPI and STAM Comparison of Teacher and Content

Teacher and Content beliefs, as measured by the TPPI, were within the teacher-centered range and changed minimally for all five teachers. While the teachers' beliefs regarding content did not appear to change, their behaviors did change and were more student-centered than their beliefs. T5's (Laura) behaviors changed the least from within the early/experienced constructivist range to early constructivist. T1 (Marie) showed a change from a low transitional/conceptual average to an average close to conceptual. T2, T3, and T4 changed their behaviors from within the range of transitional/conceptual to

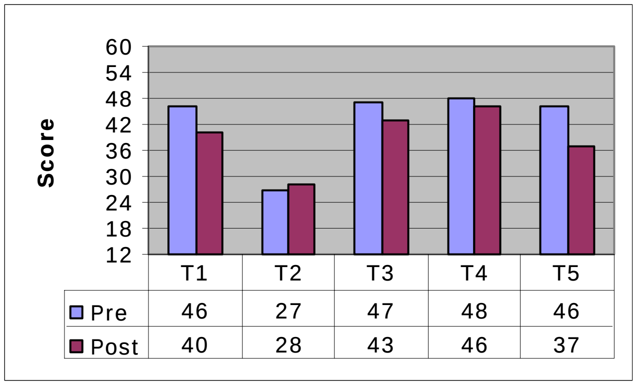


Figure 36. STEBI Outcome Expectancy Scale Comparison.

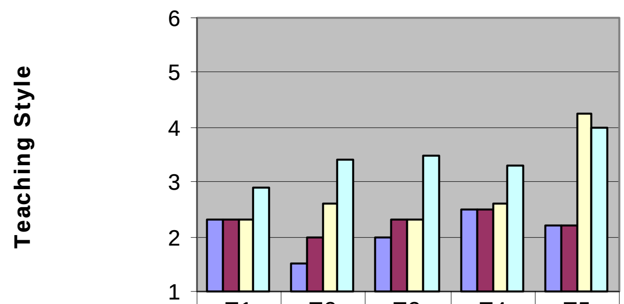
within the range of conceptual/early constructivist. Figure 37 displays the Teacher and Content Scores by participant for the TPPI and STAM instruments.

Comparison of CLES Scientific Uncertainty Subscale

There was little change for four of the five teachers' beliefs with respect to the Scientific Uncertainty scale (T1, T2, T4: "sometimes to often"; T5: "often to always"). T3 (Daphne) reported a decrease in her efforts to provide opportunities for students to view science as tentative, within the "seldom to sometimes" range. Figure 38 displays the pre and post Scientific Uncertainty scores by participant.

Modified Nature of Scientific Knowledge Scale (MNSKS)

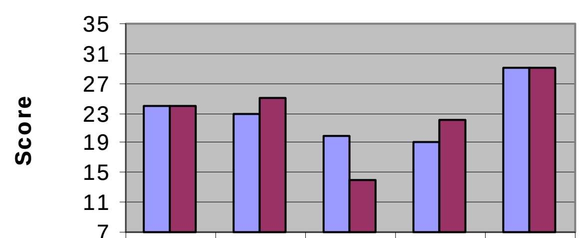
Four of the five teachers reported views within the accepted view of the Nature of Science (NOS) (score above 24) for the Creative scale before and after PI participation. T1 (Marie) increased her score three points, T2 (Tee Jay) increased ten points, T3 (Daphne) increased four points, and T5 (Laura) increased six points. T2 (Tee Jay) changed her views from an unaccepted view of the creative NOS to within the accepted view.



	T1	T2	T3	T4	T5
Pre TPPI	2.3	1.5	2	2.5	2.2
Post TPPI	2.3	2	2.3	2.5	2.2
Pre STAM	2.3	2.6	2.3	2.6	4.25
Post STAM	2.9	3.4	3.5	3.3	4

Note: 1=Didactic; 2=Transitional; 3=Conceptual; 4= Early Constructivist; 5=Experienced Constructivist; 6=Constructivist Inquiry

Figure 37. TPPI and STAM Comparison of Teacher and Content.



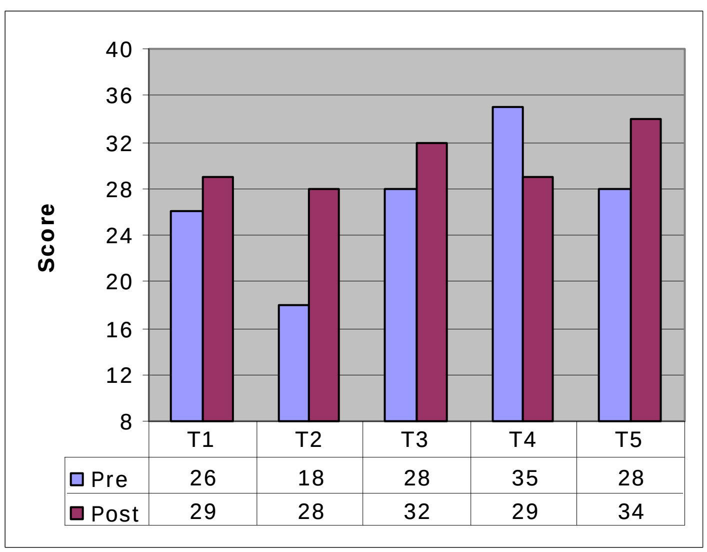
	T1	T2	T3	T4	T5
Pre	24	23	20	19	29
Post	24	25	14	22	29

Figure 38. CLES Scientific Uncertainty Scale Comparison.

T4's score notably decreased six points; however, her view remained within the accepted range. Figure 39 displays the pre and post Creative Scale scores by participant.

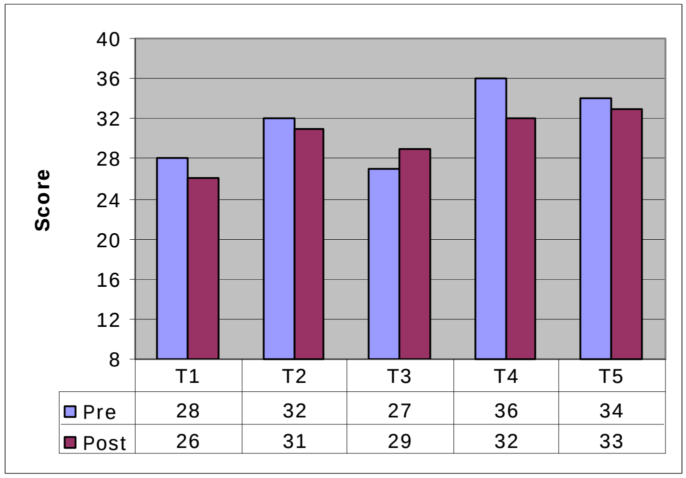
Figure 40 displays the pre and post Developmental Scale scores by participant. All five teachers reported views toward the accepted view of the NOS (score above 24) for the Developmental scale before and after PI participation. Four of the five had little change (T1, T2, T3, and T5). T4's score notably decreased four points.

One teacher, (T1- Marie) held beliefs within the unaccepted range of the NOS (score below 24 points) for the Testable Scale before and after PI participation. T2 (Tee Jay) notably increased her score seven points from within the unaccepted range to within the accepted range. T3, T4, and T5 had minimal change in their views and were all within the accepted NOS view range. Figure 41 displays the pre and post Testable Scale scores by participant.



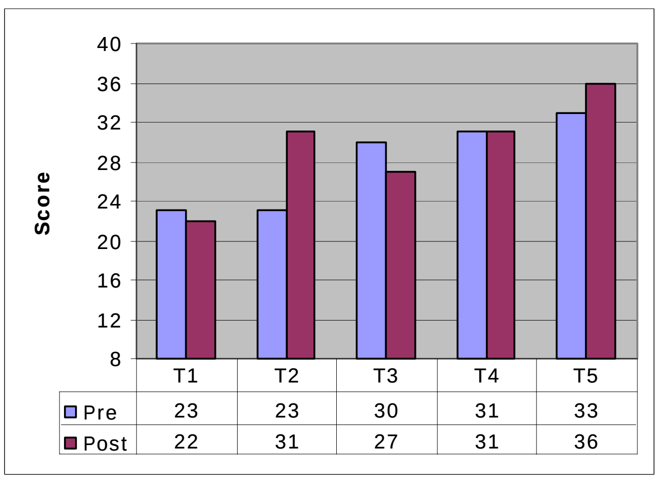
Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 39. MNSKS Creative Scale Comparison.



Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 40. MNSKS Developmental Scale Comparison.



Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

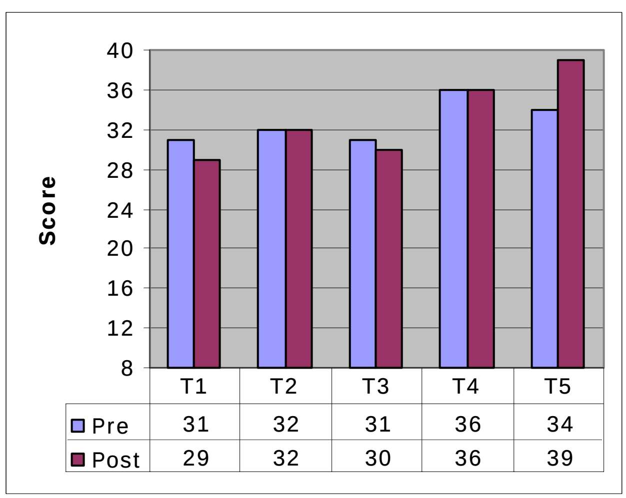
Figure 41. MNSKS Testable Scale Comparison.

All teachers had scores toward the accepted view of the NOS (score above 24) for the Unified Scale pre and post. T5 (Laura) showed a noticeable increase (five points), while the other four teachers showed little change if any. Figure 42 displays the pre and post Unified Scale scores by participant.

Figure 43 displays the pre and post Total Scale scores by participant. All teachers had scores within the accepted view of the NOS (score above 96) before and after PI participation for the Total Scale Score of the MNSKS. T1 and T3 showed negligible change. T2 (with an increase of more than 16 points, the only teacher with a notable change) and T5 improved their scores considerably, while T4 decreased her score noticeably.

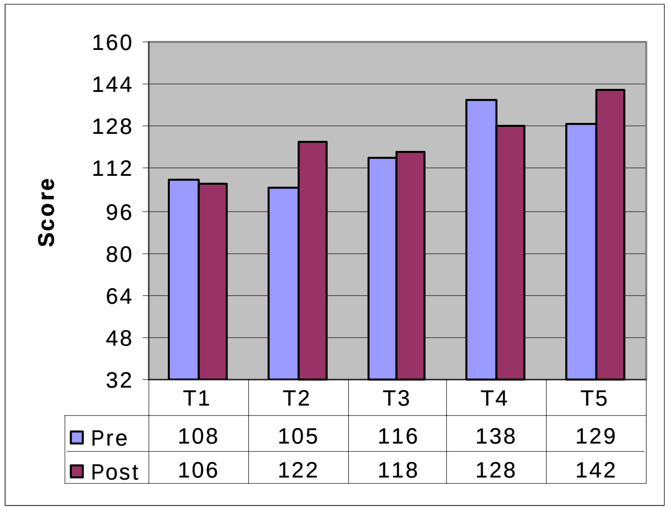
Participants' Definitions of Inquiry

T2, T3, and T4 had limited understandings of the nature of scientific inquiry prior to the PI course and developed understandings aligned with open/full inquiry that were



Note: 8-23 points = unaccepted view; 24 = neutral view; 25-40 = accepted view.

Figure 42. MNSKS Unified Scale Comparison.



Note: 32-95 points = unaccepted view; 96 = neutral view; 97-160 = accepted view.

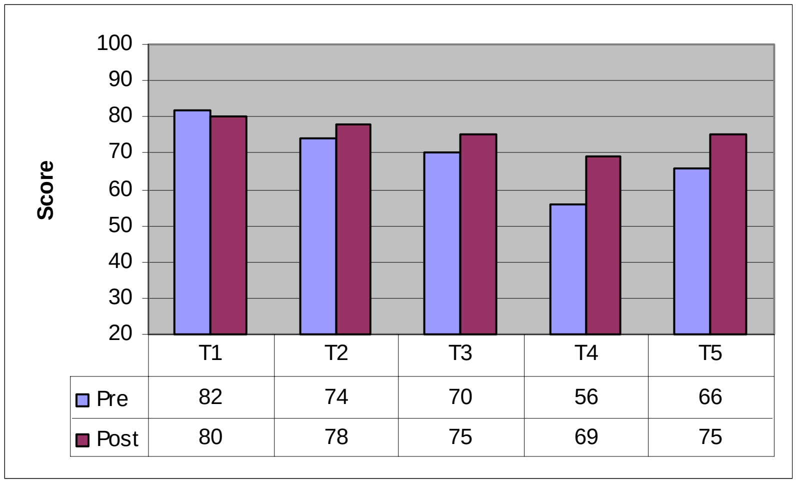
Figure 43. MNSKS Total Scale Scores Comparison.

described as part of the course. T5 had an understanding of scientific inquiry prior to participation. The reader is directed to the discussion of participants' definitions within their individual case study. Interview responses and journal reflections revealed that Marie gained an understanding that inquiry incorporated more than hands-on activities after PI participation; however, she described her definition of inquiry within the context of cookbook activities.

Question Four: Change Mentoring Strategies or Efficacy?

Mentoring Efficacy Questionnaire (MEQ)

T1 (Marie) had a negligible decrease pre to post in her mentoring efficacy beliefs and held the highest efficacy beliefs. T2-T5 all improved their scores (T2: +4; T3: +5; T4: +13; T5: +9); although, only T4 exhibited a notable change. Figure 44 displays the pre and post Mentoring Efficacy Questionnaire scores by participant.



Note: 20-40=low efficacy; 41-60=low intermediate efficacy; 61-80=high intermediate efficacy; 81-100=high efficacy

Figure 44. Mentoring Efficacy Questionnaire Comparison.

Cross-Case Themes: Participant Interviews and Reflective Journal Questions

Curriculum and Relevancy/Life Skills

Four of the five teachers stated that the curriculum standards guided their teaching prior to and after PI completion (T1, T2, T4, T5). T3 stated that her school was on "the list" as a targeted school with low test scores and there was an emphasis on teaching to the test. She incorporated curriculum standards after her participation in the course.

Each teacher described how she incorporated activities that met the curriculum but also were relevant to students' lives and/or learning styles. There was also a strong emphasis on developing life skills.

- **T1** "Students' learning styles are different and through working with them over years of time you can actually pick up what their needs are." pre-interview

- **T2** "Make sure they understand how it relates to their real world, no matter what strategy you use." post-interview

- "I don't think academics are as valuable to them as social and survival skills. You know, it's being able to socialize with somebody that may give them what they need." post-interview

- **T3** "I think every teacher has to realize that each student is a different kind of learner. You can't just teach one way every single time..." pre-interview
- "We do a lot of group work in my classroom...so they are always talking and trying to relate, 'how would it relate to us?' like-skills wise." pre-interview
- "I'm sticking to the life skills answer... I also want to add that they need to know the value of working with others and working in groups and having the social skills that they need." post-interview

- **T4** "One of the biggest things that I do in lessons is I tell them when they will use this later in life... or at home." pre-interview
- "I see the students as individuals and am able to work with them individually and not expect the same thing from every student." post-interview

- **T5** "There's an awfully wide range of characteristics of good learners. It depends on what kind of learner they are before I could describe what the characteristics are." pre-interview
- "I learned at some point that it was OK to adapt the time schedule to the kids needs and not worry so much about stuffing the curriculum down their throats." pre-interview

Beliefs about Teaching and Learning Science with Inquiry-Based Instruction - Strengths

- "Special Needs" students

T1 and **T5** discussed how the use of inquiry-based learning is helpful for working with the "special needs" child. **T2** described how she felt that certain inquiry-based activities would be setting these students up for failure.

T1 - "Peer tutoring and learning is great with the inquiry-based learning especially with the special needs child." post-interview

T5 - "Well the whole experiential, constructivist, guided inquiry method is really conducive. My whole classroom is a giant modification and it modifies for pretty much every kid. I mean they typically put resource and emotionally disturbed kids in my classroom because it's so conducive to their purpose and it really makes them comfortable in here." post-interview

T2 - "There was no way that I would have let the special needs students participate in a debate, because I knew that they could not have attempted without failure." post-interview

- PI experiences helped them learn about experimental design

T2 and **T4** wrote journal entries regarding their work with mealworms and pill bugs and how their trial and error with experiments could be learning opportunities for students regarding experimental design and work with living organisms.

- Comfort with Teaching by Inquiry

T1 (Marie) had a strong comfort for teaching hands-on lessons before and after PI participation. She consistently praised the use of inquiry-based instruction during her interviews and journal responses; however, her teaching behavior did not reflect the use of inquiry-based instruction before or after PI participation.

"Working outside the classroom and helping myself to grow this summer while taking the biology class, I learned about inquiry-based learning. I learned to motivate my children, not just by hands-on but another way of learning to get them learning. With the inquiry-based learning I can incorporate the hands-on and the curriculum." post-interview

T2 (Tee Jay) enjoyed science as a learner and teacher prior to and after PI participation. She was familiar with inquiry-based instruction but had not experienced open/full inquiry as a learner until the PI class. She expressed a desire to use inquiry-based instruction but felt constrained by the demands of the classroom to do so. After she had planned several inquiry-based lessons for a PI course requirement she expressed more comfort in planning and implementing these strategies as a beginner.

"While completing the STAM analysis, I believe that it shows what I would like to do and what I do. My ideas are there, but implementing them is where I struggle the most." Journal entry

"I think the course definitely switched my thinking and at the same time it's affecting the way I teach. I'm asking more of them than I did before. I mean, I think last

year was very controlled with reading the book and doing a worksheet. But this year, I like the progression that I have made. I just find myself standing back and letting them do the work…and I'm not as in control." post-interview

T3 (Daphne) did not enjoy teaching science prior to PI participation. She valued her experiences in the PI class and found the use of inquiry beneficial to other subjects. She also felt that opportunities provided through inquiry and through science in general could provide students with experiences that they otherwise would not get at home.

"Since the first interview, I've had the chance to experience learning by inquiry in the class with the plants…My students were able to do a unit on mealworms as part of their six weeks on animals…I've used it (inquiry) this year with other subjects, especially in math." post-interview

"There are kids in my class that come from homes where parents are not educated…So I feel like I need to accommodate these students with giving them more opportunities…It's amazing how many of my kids have not even been to the zoo…As a grade level, we've talked about more field trips when it comes to science and social studies or having people come to speak and giving them things that they should be getting at home." post-interview

T4 (Shannon) enjoyed science and teaching the subject using hands-on lessons prior to PI participation. She credited the PI course with offering her an opportunity to experience inquiry-based learning and was making efforts to incorporate inquiry-based activities after the course.

"I really love to teach science because there are so many different opportunities for experiments and hands-on lessons…But, I know that I am missing one of the most important concepts of science - experimenting for longer periods than 1 hour sessions. My students have not been exposed to any experiments that took longer than 1 class period where they were able to sketch, think, write, or discuss predictions vs. the results." Early Journal Entry

"I really feel excited about doing inquiry-based lessons in the classroom. My problem now is just finding class time to fit in inquiry-lessons with the fish or pill bugs." Late Journal Entry

"My experience with learning inquiry was really different because I'm used to being structured and I'm used to creating structure for lessons and I was basically turned

loose with other students and we were confused and frustrated. But, we were really interested and we really liked it and I think it was good because we were the ones that were doing the thinking." post-interview.

T5 (Laura) was instructing students with constructivist, inquiry-based lessons prior to PI participation. During the post-interview she stated that she felt she used guided inquiry more often (as opposed to open/full inquiry) within her classroom. She credited the PI course for providing her with opportunities to experience the frustration that her students would feel with this type of learning and with opportunities to learn more about how to question (from observing Dr. Hickok as a model).

"I can see how I would like to organize my syllabus for next year. I want to structure the learning strategies in my classroom so that children start by gaining basic inquiry investigation skills in the context of constructing content knowledge and then build up to full independent inquiry investigations. I think I will try to have them keep a reflection journal of sorts to track their responses as we go…A little metacognition goes a long way." Summer Journal Entry

Beliefs about Teaching and Learning Science with Inquiry-Based Instruction - Constraints

- Emphasis on math and reading at the elementary school level

A common constraint to the three elementary classroom teachers was that there is a high emphasis on teaching math and reading at the elementary level. The students within these urban schools generally perform at a substandard level on standardized tests.

T2 - "I feel the time constraints when you are told to push everything aside and just teach math and reading, forget everything else. You feel like, oh well, what happens if I'm teaching science and they walk in." Journal entry

T3 - I think the reason why I haven't become such a good science teacher is because they'll (administration) flat out tell you, don't teach social studies and science, focus on reading and math." pre-interview

"It upsets me because if you are spending all your time planning for the new math and reading program you don't have anything left for the other subjects which before I would have thought, 'well, I don't care anyway,' but now that I see the importance of

science through this class, it upsets me that I don't get the support to teach science and I don't get the time to plan science." post-interview

T4 - "I really feel excited about doing inquiry-based lessons in the classroom. My problem now is just finding class time to fit in inquiry lessons." Journal entry

- Access to Resources/equipment

Lack of access to necessary equipment and resources was a common constraint listed in interview and journal responses among four of the teachers (T2-T5). T1 teaches within a science lab and has access to numerous consumable and non-consumable supplies as well as technology.

- Need for experience with inquiry-based learning before they can feel comfortable teaching with that method

Four teachers commented about the need to experience inquiry-based learning or a positive experience with science before they would feel comfortable using inquiry-based instruction.

T1 - "When I was growing up in high school the teacher always taught that it's there (the answer), you learn from what I tell you, and it's not that." Journal entry

"I think that inquiry-based is a wonderfully creative tool to get the children to learn and if we can maybe help other teachers to learn that way they can, in turn, teach that way to their children. Because I think it starts with us learning and then we can motivate our children to learn as well." Journal entry

T2 - "I could say I teach the way I was taught science, where you sit in your chair and just read. When I went to college, it was more of me still sitting, but watching the professors do the show." pre-interview

T3 - "I haven't had any really positive experiences with science and that's probably why my scores are so low because I just haven't had the information...I'm embarrassed of how little science I've had." pre-interview

"My personal outcome for this course is to become a more effective science teacher." Journal entry

"I think I would have to let teachers be a part of an inquiry-based science lesson for them to grasp the concept. I think then they would realize how much more the students would gain from this way of learning." Journal entry

T4 - "To go back and do it (Project INQUIRE course) again, I would probably do so much better because I was scared that I was going to go in the wrong direction s and now I realize that there's not a wrong direction as long as I'm doing something and working toward some goal of my own. So I think the more inquiry experiences that I have the better and better they will get for me and the better and better that I will get at teaching them." post-interview

- Planning (alignment with curriculum; time to plan; pacing guide - required use and high student mobility rate; and planning motivational situations)

Four teachers commented about the difficulties of planning inquiry-based instruction.

T2 - "The curriculum that I am preparing to teach in the fall doesn't seem to lend itself to an inquiry-based environment. As I try to interpret essential questions and real-life problems for the students to construct their inquiry, I find it hard to correlate with the textbooks that are dictated by the county." Journal entry

"Everything we do is set to a pacing guide. They want us to follow it in a certain order because if a child transfers they may transfer to a class that's now teaching something that we've already taught. And I can see their point because our student mobility rate is so high." Pre-interview

T3 - "I have been overwhelmed with the beginning of school and planning my science lessons. Now that we have started a new math and reading program, science has been hard to work into my hectic schedule." Journal entry

T4 - "I would like to improve getting the lessons that hit the goal best and yet are still creative, fun, and interesting." Pre-interview

"Right now I just can only do what I can to get by and I think if I put more effort into it now, that later on the students and I will benefit." Post-interview

T5 - "Time limits in terms of class period are a constraint to spending time on what students really need."

"I am struggling to find a way to set up situations which will allow my kids to truly pursue inquiry. I want them to be able to have time to get motivated about their

investigation, really plan, design, set up, etc. I want them fully immersed and I am only there as an assistant, materials procurement person, and co-investigator." Journal entry

- Individual constraints (Working with oppositional students; lack of content knowledge)

T2 expressed difficulty giving students more control to complete inquiry-based lessons when they have oppositional behavior. **T5**, who taught with a student-centered approach prior to and after PI participation wrote, "Though I was never really intimidated by the fact that I didn't have all of the answers, I was concerned at times that I wouldn't be able to give the children as full a comprehension as they could have."

Strengths in Mentoring Science Teachers

In response to the question, "What do you feel are your greatest strengths as a science mentor?" the participants had various responses as described below. **T1** and **T4** felt that their experience with creating hands-on lessons was beneficial. **T2**, **T3**, and **T4** describe affective strengths such as patience, willingness to listen, and encourage other teachers.

- **T1** - Pre and post - Developing hands-on lessons
- **T2** - Pre- Willingness to take risks; Post - Creating Inquiry-Based lessons
- **T3** - Pre - Enjoy sharing with new teachers; Post - Patience and willingness to help
- **T4** - Pre - Love science, has energy to supply as a teacher/mentor, ability to listen, and experiences with hands-on lessons; Post - Can listen and encourage, help teachers with individual needs
- **T5** - Pre and Post - Experience with inquiry and constructivist theory and strong content knowledge.

Challenges of Mentoring Science Teachers

In response to the question "What do you feel are your greatest challenges as a science mentor?" the participants had various responses as described below. **T1** and **T5** expressed similar concerns about mentoring teachers who may be resistant to change. **T3** and **T4** expressed similar concerns about being new teachers and needing more experience with the subject.

- **T1** - Pre - Help mentee understand science standards and concepts; Post - Working with a teacher or student that resists learning.
- **T2** - Pre- Confidence to be viewed as a science expert; Post - Materials/resources
- **T3** - Pre - Need to gain a better understanding of subject before she feels prepared to help; Post - She had a better understanding of how to design an Inquiry-based unit, but still a new learner
- **T4** - Pre - She's a new teacher; inexperienced, has a lack of patience for completing experiments with complete accuracy; Post - There is never enough time to mentor, have to give something up to mentor
- **T5** - Pre and Post - Working with established teachers who are set in their ways.

Mentoring Activities PI Teachers Have Initiated or Plan to Initiate

All five teachers expressed an interest to share their experiences from the PI course with teachers at their school through mentoring. **T1** (Marie) wanted to plan a year-long inquiry-based professional development opportunity for teachers at her school to allow them to experience inquiry as learners and then give them time to transfer the

learning to their teaching. **T1** planned to meet with the teachers after school or during inservice days to provide the experiences.

T2 (Tee Jay) developed a school science committee to catalog science resources within the building for easier access and develop inquiry-based lesson plans. She asked a representative from each grade level to create an inquiry-based lesson plan to share with the committee and then with teachers at his/her grade level. She shared the 5-E lesson planning process and several of the handouts from the PI course with the group.

T3 (Daphne) was excited to share the inquiry-based process with her grade-level team. She planned to initiate a discussion with her team that was held in the PI course about the differences between problem-solving and inquiry. She also planned to help the other teachers have an opportunity to experience inquiry-based learning because she didn't think they would understand the concept without doing so.

"I think they would realize how much more the students would gain from this way of learning. Many teachers would definitely try teaching science this way if they had the opportunity. However, I think my school would need more money and planning time to actually give the students a successful science program."

T4 (Shannon) expressed excitement about mentoring other teachers to use the inquiry-based process and described how although she would be in her 2nd year of teaching, she would be one of two teachers left out of six on the 5th grade team. However, she felt concerned about being a new teacher and using limited time to mentor other teachers.

"I am also very close with the 4th grade team and I will share with them as well. I will probably be able to do this through my planning time. Now I will be able to share with them how to take the problem solving activities from the textbook and turn them into inquiry activities. Most of the team is made up of very interested teachers who will be willing to try new things." Journal entry

T5 (Laura) shared her experiences with inquiry-based learning and teaching informally with the two other 6th grade teachers and one 7th grade teacher at her school. One of the 6th grade teachers made observations of her teaching. Laura expressed concerns with working with other teachers who resisted changing their methods.

Summary of Findings

A review of the data provided in this chapter for the five teacher case studies suggests the following key findings:

1. Regarding research question one:
    a. The participants' behaviors after participation in the course were positively influenced.
        i. T2, T3, and T4 changed behaviors from transitional/conceptual to conceptual/early constructivist.
        ii. T1 changed behaviors from transitional/conceptual to conceptual.
        iii. T5 maintained student-centered behaviors from early to experienced constructivist.
    b. Their beliefs about their behaviors (TPPI-Teacher Actions, TA) remained the same - teacher-centered/conceptual, with one exception. T1 changed her TPPI-TA beliefs from transitional/conceptual to early constructivist.
2. Regarding research question two:

a. Participants' beliefs as measured by the TPPI - Student Actions (SA) and Philosophy of Teaching (PT) interview questions did not change. They were conceptual to conceptual/early constructivist.

b. Their behaviors as measured by the STAM - SA aspects changed to become more similar to their beliefs.

    i. T1-T4 exhibited teacher-centered (didactic and transitional) behaviors before the course and conceptual/early constructivist behaviors after the course.

    ii. T5 maintained student-centered behaviors before and after the course.

c. Beliefs as measured by the CLES instrument:

    i. All teachers generally held a high intermediate to high agreement with the Personal Relevance and Attitude scales of the CLES, which correlated with their journal and interview responses.

    ii. T3 and T4, novice teachers, generally scored lower on all scales than the other three teachers.

d. Beliefs as measured by the STEBI instrument:

    i. T3 and T4, novice teachers, showed notable increases in their Personal Science Teaching Efficacy scores, while the other three teachers maintained a high personal efficacy belief.

    ii. The teachers Outcome Expectancy (OE) scores were generally lower than their personal efficacy beliefs. T1, T3, and T5 had

notable decreases in this scale after course participation, while T4 had a slight decrease. Tee Jay maintained a low OE score.

e. Reflective journal responses:

    i. T2, T3, and T4 felt constrained to teach science due to the emphasis placed on math and reading at the elementary level.

    ii. Four of the teachers (T2-T5) felt that the lack of resources for teaching science was a constraint to I-B instruction. T1 taught in a fully equipped science lab and did not mention a lack of resources as a constraint.

    iii. Four of the teachers (T1-T5) commented about the need to experience I-B learning before they could be comfortable teaching with I-B instruction.

3. Regarding research question three:

    a. Their beliefs about science content remained the same as measured by the TPPI - Teacher and Content (TC) after course participation. These beliefs were transitional/conceptual.

    b. The participants' behaviors regarding content as measured by the STAM, Content (C) aspect, were positively influenced after participation.

        i. T1 changed from transitional/conceptual to conceptual behaviors regarding content.

        ii. T2, T3, and T4 changed from transitional/conceptual to conceptual/early constructivist behaviors regarding content.

iii. T5 maintained student-centered behaviors regarding content.

c. Beliefs regarding the Nature of Science (NOS) as measured by the MNSKS instrument

   i. The creative measure of the NOS revealed the most changes. T2, T3, and T5 showed notable increases in their understanding of the creative NOS; while T4 showed a notable decrease. T1 had a slight increase in her creative scale score.

   ii. T2 changed her views from an unaccepted view of the creative and testable NOS to an accepted view, while T1 maintained an unaccepted view of the testable NOS.

d. There was little change detected in the participants' agreement with the Scientific Uncertainty (SU) scale scores of the CLES instrument, with the exception of a notable decrease in T3's agreement within the low intermediate range. T1, T2, and T4 held low to high intermediate agreement and T5 held a high agreement with the SU scale before and after the course.

e. Participants' definition of inquiry:

   i. T1-T4 changed their definition from an activity perspective to an open/full perspective; however, T1 did not translate this understanding to practice.

   ii. T5 held an understanding of the difference between an activity and an open or guided inquiry before and after course participation.

4. Regarding research question four:

    a. Participants' perceived efficacy towards mentoring as measured by the Mentoring Efficacy Questionnaire (MEQ):

        i. T2, T3, T4, and T5 had increases in their total MEQ scores within the high intermediate range. T4 was the only teacher with a notable increase (+ 13 points). T1 had a negligible in her mentoring efficacy total score; however, it was within the high efficacy range.

        ii. T2, T3, and T5 felt uncertain about their ability to mentor teachers in I-B instruction before course participation; however, they felt confident with this aspect after the course. T1 felt less confidence in this aspect after the course. T4 felt confident before and after the course; however, she did not have an accurate perception of I-B instruction before the course.

CHAPTER V: CONCLUSIONS, DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Organization of the Chapter

This chapter presents conclusions and lessons learned from the case studies, a comparison of results with those found in the literature, implications for practice, and recommendations for further research. The chapter is organized into five sections:

(1) Summary of Purpose, Methodology, and Participants

(2) Conclusions

(3) Discussion

(4) Implications for Practice

(5) Recommendations for Research

Summary of Study

Purpose of the Study

The purpose of this study was to examine the impact of an inquiry-based professional development course on five urban, elementary teachers' science practices and beliefs regarding science, science teaching, and mentoring. Inquiry-based (I-B) instruction was described as a culturally relevant, student-centered, and constructivist practice appropriate for use in these urban settings. An assumption of the researcher was that these teachers had not had prior experiences with I-B learning and therefore would benefit from I-B professional development (I-BPD).

The four research questions examined for this study include:

1. Do teachers who complete Project INQUIRE change their instructional practices after participation in the course? If so, how are their practices different?
2. Do teachers who complete Project INQUIRE hold different beliefs and attitudes about science instruction after participation in the course? If so, how are their beliefs and attitudes different?
3. Do teachers who complete Project INQUIRE change their understanding of scientific literacy after participation in the course? If so, how does it change?
4. Do teachers who complete Project INQUIRE change their strategies and their perceived efficacy toward mentoring their colleagues after participation in the course? If so, how do they change?

Review of Methodology

As outlined in Chapter III, this study utilized a collective case study methodology to answer the research questions. A number of data sources were used to triangulate findings for each research question. The primary instruments used were interviews and observations with surveys and journal reflections used as supplementary instruments. Interviews, observations, and surveys were collected prior to and after participation in the Project INQUIRE (PI) course. The reflective journal questions were collected during the PI course.

An interview composed primarily of questions from the *Teacher's Pedagogical Philosophy Interview* (TPPI) (see Appendix C) was used to examine changes in each teacher's practices, beliefs about teaching, and understanding of scientific literacy. Classroom observations were coded using the *Secondary Science Teachers Analysis*

Matrix (STAM) (see Appendix D) to determine changes in instructional practices. The *Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs* (SIDESTEP*)* (Appendix E) was used to provide demographic data about each participant as well as additional information regarding teacher practices that would not be obtained from observations alone. The *Constructivist Learning Environment Survey* (CLES) (see Appendix F) was used to determine changes in teachers' perceptions about the use of constructivist teaching practices and their understanding of the nature of science (Scientific Uncertainty scale). The *Science Teaching Efficacy Belief Instrument* (STEBI) (Appendix G) was used to determine changes in each teacher's personal science teaching efficacy and outcome expectancy beliefs. The *Modified Nature of Scientific Knowledge Scale* (MNSKS) (Appendix H) was used to measure changes in participants' understandings of the nature of science. The *Mentoring Efficacy Questionnaire* (Appendix I) was used to determine changes in the teachers' perceived efficacy in mentoring other teachers in the use of inquiry-based practices. *Reflective Journal Questions* were used to provide supplemental information regarding changes in each teacher's beliefs and attitudes toward science instruction, understanding of scientific literacy, and perceived efficacy and strategies for mentoring other teachers.

Review of Participants

Of the five teachers included in this research, three teachers (T2, T3, and T4) were novice teachers. Although T3 had six years teaching experience at the beginning of this study she had minimal positive experiences with teaching science. Two teachers, T1 and T5, were considered to be experienced teachers with 28 and 13 years of experience respectively. Table 39 summarizes pertinent demographic information regarding each

Table 39. Participant and School Demographics.

Name - T#[a]	Years Experience[b]	Grade Level	Students With Economic Disadvantage[c] - %	Minority Students[c] - %
Marie - T1	28-29	K-2	86.5	87.3
Tee Jay - T2	3-4	3rd (pre) 5th (post)	90.1	43.8
Daphne - T3	6-7	4th (magnet - pre; non-magnet - post)	90.7	81.0
Shannon - T4	1-2	5th	75.0	27.0
Laura - T5	13-14	6th	59.8	32.5
County[d]	--	--	31.0	17.9

[a]T#: Teacher number, pseudonyms are used. [b]Indicates number of years experience teaching during the pre and post observations. [c]Percentage for entire school. [d]Percentage of economically disadvantaged and minority students from the represented county to compare to the percentages represented in the participants' urban schools within the county.

teacher and their respective school. The table also includes the percentage of students with an economic disadvantage (receive lunch assistance) and the percentage of minority students (non-Hispanic White) for the entire county for comparison with the participants' urban schools. Although approximately a third of the county's students have an economic disadvantage, each of the urban schools represented in this study had 60-90% economically disadvantaged students. The urban schools had between 27 and 87% minority students (the majority of which were African American) enrolled, whereas the county had approximately 18%.

Conclusions

Question One - Change in Instructional Practices

The course seemed to positively influence most of the teacher's behaviors; as measured by the STAM instrument. TeeJay (T2), Daphne (T3), and Shannon (T4)

showed changes in their behaviors from transitional/conceptual to conceptual/early constructivist. Marie's (T1) behavior changed from the teacher-centered/conceptual range to primarily a conceptual range. Laura's (T5) behaviors remained in the early to experienced constructivist range.

Question Two - Change in Beliefs and Attitudes about Science Instruction

While the teachers exhibited changes in their behaviors, these changes were generally not reflected by changes in their beliefs as measured by the TPPI instrument. In most cases there was no change in teachers' beliefs as measured by the CLES instrument; however, there were some notable exceptions. Novice teachers generally showed an increase in personal science teaching efficacy while experienced teachers were already confident in their practices as measured by the STEBI instrument. On the other hand, the STEBI outcome expectancy beliefs were generally lower than the personal science teaching efficacy beliefs and there was even a general decrease in outcome expectancies after the course.

Question Three - Change in Understanding of Scientific Literacy

The teachers views of science content were teacher-centered as measured by the TPPI questions and showed negligible change; however, participants showed changes in their understanding of scientific inquiry and the Nature of Science (particularly the view of science as creative) after participation in the PI course. This increase in the understanding of scientific inquiry may be connected to the observation that there was a general increase in student-centered instruction regarding content, as measured by the STAM. The participants, whose beliefs were congruent with their behaviors before the course, demonstrated behaviors that surpassed their beliefs after course participation.

Question Four - Change Strategies and Perceived Efficacy Toward Mentoring Colleagues

Participation in the PI course generally increased the teachers' perceived efficacy toward mentoring other teachers to use inquiry-based instruction and mentoring in general. None of the five teachers had previously mentored other teachers (formally) in the field of science prior to the PI course. After the course each teacher had formal and informal plans to mentor other teachers within their respective schools. Formal practices included: (1) professional development offered during inservice days and after-school to provide inquiry-based experiences over the length of the school year to teachers within the school and (2) developing a school science committee responsible for cataloging resources, reading current articles in science education, and developing/sharing inquiry-based lessons. Informal practices included discussing and planning inquiry-based lesson plans as grade-level teams and providing opportunities for other teachers to observe inquiry-based instruction.

Discussion

Comparison of Beliefs and Instructional Practices

The teachers who participated in the PI course did not change their beliefs regarding Teacher Actions (TA), Student Actions (SA), Philosophy of Teaching (PT), or Teacher and Content (TC) as measured by the TPPI with one exception. Marie (T1) increased her beliefs for TA from a teacher-centered view to an early constructivist view. It is interesting to note that although the teachers' beliefs did not change, their behaviors as measured by the STAM did change, with two exceptions. Marie (T1) displayed

teacher-centered behaviors for TA before and after the course, while Laura (T5) displayed student-centered behaviors for all categories before and after the course.

While the teachers generally held teacher-centered beliefs for TA and TC, their behaviors surpassed their beliefs after PI participation toward a conceptual/student-centered level. They held conceptual/student-centered beliefs for SA and PT and their behaviors became more congruent with their beliefs after the course. This research can be compared/contrasted to two research programs, Salish I (Simmons, et al., 1999) and Inquiry-Based Demonstration Classroom (Luft, 2001), which used the STAM and TPPI instruments. The Salish I study found that novice teachers held student-centered beliefs and described their practices as student-centered, while their behaviors were teacher-centered. Luft (2001) found that novice teachers are more likely to change their beliefs, whereas experienced teachers are more likely to change their behaviors in response to professional development. Although the current study found no general distinctions that could be drawn between the novice and experienced teachers, there were differences found between Laura, the teacher who was experienced with I-B instruction, who had negligible changes in her beliefs and behaviors, and the teachers with little experience with I-B instruction, who had emergent constructivist behaviors in TA, SA, and TC after course participation. It is interesting to note that the participants' beliefs, although they did not change, varied depending on the aspect observed. They held teacher-centered beliefs for TA and TC and conceptual/student-centered beliefs for SA and PT.

One observation that should be noted is that the TPPI scoring maps for the Teacher and Content questions only have codes for responses in the didactic, transitional, and conceptual styles. One area for further study would be to extend the TPPI maps to

include codes for student-centered styles for the Teacher and Content section. All five of the teachers could have possibly scored in a conceptual to early constructivist range had there been codes for these styles. In this case their behaviors would have become congruent with their beliefs after course participation.

One would expect behaviors to reflect beliefs; however, although teachers often believe that constructivist styles of teaching are appropriate for students, they have had little experience with this type of instruction as learners. Teachers need to have inquiry-based experiences if they are expected to teach with the method (Duggan-Haas, 1998; Melear et. al, 2000; Radford & Ramsey, 1996; Schwartz et al., 2000; and Villegas & Lucas, 2002). It is interesting to note that four teachers (T1-T4) expressed the need to have an opportunity to experience inquiry-based learning (as they had in the PI course) before they were comfortable using inquiry-based instruction. Generally they held student-centered beliefs for SA, PT, and possibly TC and the experiences in the PI course helped them to align their behaviors with their beliefs.

The two additional non-TPPI-interview questions were powerful indicators of participants' understanding of the meaning of inquiry and their experiences teaching and learning with the process (Luft, 2001 also used these questions). It was important to ask the participants to operationalize their definition of inquiry in order to determine their understanding of the term. After the course, all participants could distinguish between the definitions of an activity and guided or open inquiry. Four of the teachers (T2-T5) were able to describe actual experiences of learning or teaching with inquiry after the course. However, Marie (T1) described teacher-centered/conceptual activities rather than student-centered inquiry.

The CLES instrument was used to determine the participants' self-rated perceptions of their teaching environments using constructivist approaches measuring personal relevance, scientific uncertainty, critical voice, shared control, student negotiation, and student attitudes. Whether the teachers' beliefs, as measured by the CLES, changed or remained the same, the CLES responses generally correlated with their emergent conceptual/student-centered behaviors (T1-T4). It is interesting to note that two of the three novice teachers (T3 & T4) generally scored lower on all six scales than the other three participants. Another notable mention is that Laura's (T5) beliefs as measured by the CLES were more in agreement with her student-centered teaching behaviors (displayed before and after course participation) than her beliefs as measured by the TPPI instrument. All five teachers scored high with little changes on the personal relevance and student attitude scales and there were some notable changes within the other four scales but no general trend was evident. As described in the culturally relevant teaching literature regarding African American students, providing a bridge between the home environment and the school environment is critical to students' academic, social, and emotional achievement (Gay, 2000; Guild, 2002; Shade, 1997; Shade, Kelly, & Oberg, 1997). However, while it is important for teachers in urban schools to encourage social skills and personal relevance, it is also important for teachers to uphold high academic standards.

Teaching Efficacy Beliefs

There were notable differences between the novice and experienced teachers as measured by the personal science teaching efficacy scale of the STEBI instrument. While Daphne (T3) and Shannon (T4) generally scored lower on their perceived

implementation of constructivist practices (CLES), their perceived ability to teach science improved after course participation. The other three teachers retained confident beliefs (high efficacy range) in their teaching abilities.

All five teachers had considerably lower outcome expectancy belief scores than their personal science teaching efficacy scores and three teacher's beliefs had a notable decrease after the course. The outcome expectancy beliefs are an indication that although the teachers felt that they could teach science effectively, they felt that there were other circumstances that prevented students from making academic improvements. It should be noted that there is a link between the learning context and the learner's construction of knowledge. Learning is mediated by previous experiences, the current social context, and interactions with other learners or knowledgeable others (Bourdieu & Passeron, 1979; Jegede & Aikenhead, 1999; Plourde & Alawiye, 2003; Rodriguez, 1998; Vygotsky, 1978). Extenuating circumstances mentioned by the participants in reflective journal and interview responses included a lack of emphasis placed on science instruction within the school, the lack of resources, difficulties with planning I-B instruction, working with oppositional students, short class periods (or time devoted to science in the school day) and lack of content knowledge (on part of the teacher). These circumstances were mentioned in the literature along with a difficulty for novice teachers who are overwhelmed due to the pressures of teaching during the induction period (Adams & Krockover, 1999; Haberman, 1991; Jorgenson & Vanosdall, 2002; Mulholland & Wallace, 2001; Supovitz & Turner, 2000; Von Secker & Lissitz, 1999).

Another suggestion for the decrease in outcome expectancy is that the teachers became more knowledgeable about what is needed to make changes in student learning

as a result of participation in the course. They may have viewed student achievement as more of a challenge and lost some confidence in this area. Three questions worth considering include, "How would the results have been different or similar if the study had been conducted in suburban or rural schools rather than urban schools?", "Do teachers in urban settings hold lower expectations of students?" and "Can primary-aged (K-3) children be expected to conduct open inquiry?"

Understanding of the Nature of Science

The inclusion of the measure of participant's understanding of the Nature of Science (NOS) was included primarily because of the notion that teachers often do not have an adequate understanding of the NOS, which is a critical component for scientific literacy (Lederman et al., 2002; Schwartz & Crawford, 2003). Of the four measures for NOS, all participants held an understanding within the accepted range for the developmental and unified dimensions of the NOS before the course began with minor changes in their understanding. Participation in the course assisted Tee Jay (T2) in changing her views from an unaccepted to accepted view in the creative and testable scales; however, Marie (T1) retained an unaccepted view of the testable NOS even after course participation. Two teachers (T2 & T4) stated in journal entries that they felt learning by inquiry helped them learn about experimental design. Participants were asked to read in the *Benchmarks* (AAAS, 1993) about the NOS for their particular grade level and discuss its suggestions as part of class discussions in preparation for designing I-B lessons. The PI course was designed to allow teachers to participate in I-B activities and then discuss the aspects of inquiry and the NOS that were evident in the activities. The explicit discussion of the NOS was conducted in response to suggestions in the

literature to provide opportunities for students and teachers to reflect upon their actions and explicitly discuss the NOS (Khishfe & Abd-El-Khalick, 2002; NBPTS, 2001; Schwartz & Crawford, 2003).

Mentoring Efficacy Beliefs

As mentioned, four of the five teachers felt better prepared to mentor other teachers and to assist them with implementing I-B practices. It is interesting to note a difference in the concerns between novice and experienced teachers regarding their perceived challenges to mentoring. The experienced teachers were concerned about working with teachers that were resistant to change, while the novice teachers were concerned about being expected to mentor as novice teachers and the lack of resources.

Implications for Inquiry-Based Professional Development for Urban Teachers

The Project INQUIRE course was designed using the principles of effective development suggested by the *NSES* (NRC, 1996) as a guide. Project INQUIRE was a comprehensive PD program which included opportunities for the teachers to learn content through inquiry, learn to teach through inquiry, and learn skills and attitudes for lifelong learning.

Five areas, that were addressed in this research, were mentioned as components of inquiry-based professional development programs in need of further study by Keys and Bryan (2001). These areas include: 1) research in a culturally diverse setting; 2) inquiry-based instruction designed by teachers; 3) research regarding inquiry in the regular classroom; 4) teachers' knowledge and views about the goals and purposes of implementing inquiry; and 5) teachers' motivation for inquiry teaching. The setting chosen for this research was regular classrooms (with the exception of one science lab

instructor - T1) within culturally diverse urban elementary schools and one middle school, with a high percentage of economically disadvantaged students and a large percentage of African American students. Each teacher was asked to develop and implement inquiry-based lesson plans as part of the course. Areas four and five were a smaller focus of this study and were addressed by teachers' responses to interview questions and reflective journal responses.

Several recommendations for I-BPD described in the literature were used in this study and were found to be useful. These recommendations included: collaboration between a scientist and a science educator (Lederman, et al., 2003; Melear, et al., 2000; Radford & Ramsey, 1996); collaboration, networking, and professional discourse as part of a learning community (Lederman et al., 2003; Staten, 1998); opportunities for follow-up guidance and feedback regarding I-B instruction (Luft, 2001; Maor, 1999); and the use of observation instruments to help redirect teaching styles (Adams & Krockover, 1999; Staten, 1998). Participants emailed each other regularly, particularly in the summer, to discuss coursework. Each participant regarded using the STAM instrument as an opportunity to reflect upon teaching practices and find ways to change them to incorporate more student-centered behaviors. Although the STAM instrument can be a complicated instrument to learn, the teachers were able to use the matrix accurately with little training.

Although Supovitz and Turner (2000) found that it generally took 80 hours of PD to observe changes in I-B teaching practices, the results from this study indicate that the teachers made notable changes to their practices after 50 hours of PD. While Marie (T1) was not able to finish the entire course, she made changes in her beliefs and behaviors;

however, it would have been interesting to see her results had she finished the course. Although the teachers made changes in their instructional practices after 50 hours of PD with the Project INQUIRE course, in most cases this resulted in emergent constructivist behaviors (conceptual/early constructivist). It would be helpful to continue the professional development for these teachers and give them feedback on their teaching practices in order to help them strengthen their emergent skills.

Pedagogy of Poverty

Students in urban schools often do not have an equal opportunity to experience learning by inquiry due to the "pedagogy of poverty" that is often exhibited in these schools (Haberman, 1991; Supovitz & Turner, 2000; Von Secker & Lissitz, 1999). This pedagogy is characterized by under prepared teachers, insufficient materials, and a lack of support for innovative practices. The school system in which the study was situated reflected the general gap in science achievement favoring non-Hispanic White students and students with a high socioeconomic status in the system's suburban schools. The system's urban schools suffered from a high teacher attrition rate and a high student mobility rate.

In general, the first three to five years of teaching are known as the "survival" period often characterized by teacher-centered practices (Adams & Krockover, 1999; Simmons et al., 1999). Once teachers make it through this period they can potentially develop student-centered practices and the use of professional development can assist them with this transition. It should be noted that due to attrition rates (Easley, 2000; McCreight, 2000), teachers within urban schools often become mentors before they make it through the survival period (similar to the analogy of babies having babies for teenage

mothers). An important extension of the Project INQUIRE course was for the teachers to prepare to mentor other teachers within their schools regarding the use of inquiry-based instruction. As noted two (T2 and T4) of the five teachers had less than three years of experience teaching. T3 (Daphne) was considered a novice teacher, even though she had taught for six years, because of her inexperience with science. Although these three teachers were in the beginning stages of their careers they were expected to mentor "new teachers" because they ultimately had more experience. The emphasis on mentoring was an effort to increase the sustainability of this professional development course. Teachers who are members of mentoring teams have an opportunity to follow-through with sharing their expertise with other teachers within their school.

A finding that was similar to other research endeavors was a high emphasis placed on teaching reading and math at the elementary level, often to the exclusion of science (Jorgenson & Vansodall, 2002; Mulholland & Wallace, 2001). Professional development designed to prepare elementary teachers to integrate these subjects would make a significant impact on the incorporation of science at the elementary level. Subject integration should also be an important component of preservice teacher preparation.

Cultural Pedagogical Content Knowledge

In addition to the science pedagogical content knowledge (PCK) that teachers should possess in order to teach science, they need to have Cultural PCK. Cultural PCK includes knowledge about teaching strategies that work well with particular cultures and is exemplified by being informed about students' home lives, racial/ethnic tendencies, learning styles and socioeconomic status. This kind of PCK should be considered by

teachers when they are preparing lesson plans for a diverse group of students in order to differentiate instruction. A student's predispositions (habitus) for learning are highly influenced by his/her culture (Bourdieu & Passeron, 1979; Jegede & Aikenhead, 1999).

There should be professional development opportunities for urban teachers to learn about the diverse cultures of the students that they are teaching, particularly due to the fact that the majority (84%) of teachers are non-Hispanic White. The primary student culture relevant to this study included African American (AA) students. Characteristics of the AA culture that are particularly suited for inquiry-based instruction are group unity and cooperation through a kinship system (Shade, 1997) and the psychological dimensions of verve (need for high levels of stimulation) and expressive individualism (Boykin, 1986). The inquiry process is highly creative and often takes place as part of cooperative learning activities. AA learning styles have been referred to as field dependent (Irvine & York, 2001), characteristics of which would require a careful scaffolding of inquiry activities. For example, while field dependent learners focus on people rather than things and approximate space and numbers rather than focusing on specific details, science requires attention to specific details and often requires a focus on objects rather than people. Research regarding AA learning style preferences, as measured by the MBTI, at the elementary and middle school level (the levels addressed in this research), correlates with the field dependent preference with the MBTI preference for feeling (F) in which students need a personalized learning environment (Melear & Alcock, 1999). Researchers recommend the use of movement, small group work, alternative strategies (such as inquiry, cooperative learning, and options in assignments), and alternate assessments (such as performances) to increase the motivation and

achievement levels of AAs. (Hale, 2001; Irvine & York, 2001; Melear & Alcock, 1999; McElroy & Hollins, 1999; Shade, Kelly, & Oberg, 1997). AAs are often taught to be wary of people outside of their kinship system, which can create opportunities for miscommunication when their teacher is not from the AA culture and knows little about their culture (Irvine & Armento, 2001; Shade, 1997).

It should be noted, however, that the major focus of this particular research was on providing inquiry-based experiences for urban teachers who already possessed an understanding of Cultural PCK. Although they knew that hands-on instruction was appropriate for their students several did not have an accurate understanding of the meaning of inquiry-based instruction or have the prerequisite experiences in learning with inquiry in order to implement the practices effectively in the classroom. An area in which these teachers could improve is providing inquiry-based lessons which address the particular strengths, weaknesses, and difficulties facing their schools' community (Barton, 2000; Roth, 1995; Shade, Kelly, & Oberg 1997). The inquiry-based instruction that was observed in these teachers' classrooms, although it could be considered personally relevant and interesting to students, lacked a community-based focus. However, for the majority of these teachers this was a beginning point for learning to conduct inquiry and implement inquiry-based lessons. Professional development should be differentiated according to the styles of instruction that teachers exhibit as they begin the professional development. For example, Laura exhibited an early to experienced constructivist type method of teaching and, since she had acquired a comfort level with this type of teaching, she could have been encouraged to develop lessons that incorporated both inquiry and culturally meaningful issues. Another area that could be

addressed in I-BPD would be differentiating for primary (K-2), upper elementary (3-5), middle, and subject specific areas for high school (9-12). For example, Marie could possibly have benefited from receiving specific lesson ideas for primary students.

Recommendations for Research

General research recommendations include:

- Use a variety of instruments and methods to triangulate results based upon the research questions. The use of multiple instruments in this study helped provide a more accurate picture of the beliefs and behaviors of each teacher.
- Pre and post observations should be at the same time of the school year when observing for changes in inquiry based instruction. The timeline used in this study, pre observations in the second semester of one school year and post observations in the first semester of the next school year, appeared to work well for observing teachers with little experience teaching with inquiry (their behaviors generally changed from teacher-centered to conceptual/student-centered). However, it was difficult to see changes with the teacher who had experience teaching with inquiry. The experienced teacher was in the process of helping students to develop their inquiry-based practices in the first semester and could have shown distinct growth by the second semester, if she had been observed then. Therefore, a suggestion for an improved research design for this study (and similar efforts) would be to initiate observations in the second semester of one school year, followed by professional development through the summer and fall semester of the second school year. Post-observations should be conducted during the spring semester of the second school year.

Recommendations for additional research regarding I-BPD that have developed from this study include:

- More efforts need to be made to recruit high school teachers for I-BPD. This is an area of research that needs further study as recommended by Keys & Bryan (2001).
- Conduct a follow-up study with the same teachers involved in the current study to determine if they are continuing to include inquiry-based instructional practices within their classrooms. Additional professional development could be provided on an as needed basis.
- Provide differentiated professional development to meet the diverse needs of teachers. Analysis of the interviews, observations, and questionnaires used prior to the PD experiences could be used as pre-assessment for designing the PD based upon the needs of the teachers. Two groups within the Project INQUIRE class were those with inquiry-based teaching experiences (T5) and those without (T1-T4). While these two groups can benefit from participating in PD together they need specially-designed experiences to meet their unique needs. An ideal method would be to allow the teachers to participate in the same inquiry-based activities collaboratively and then scaffold their transition to the classroom based upon their individual needs by providing suggestions and feedback for lesson planning. Teachers with little to no experience with inquiry-based teaching should develop plans to transition from activity/cookbook lessons toward guided inquiry lessons. Teachers with experience using inquiry should be encouraged to develop open/full inquiry-based lessons based upon student interests. Other levels of

differentiation include grade levels, subject specific needs, and novice versus experienced teachers. The integration of subject areas (i.e., math, reading, and science) at the elementary level would also be recommended.

- Another extension involves incorporating student performance and beliefs as part of the research design in order to demonstrate the effect of inquiry-based instruction on student achievement. The teachers could be observed, interviewed, and surveyed over the length of a school year (at beginning, mid, and end of year). Students should be observed, interviewed, and surveyed at the same points during the year. The student versions of the CLES instrument and an age-appropriate NOS measurement can be used for the surveys. Student achievement can be measured using a combination of content knowledge measures including standardized test questions and performance-based questions. Student and teacher behaviors and beliefs should be compared and contrasted. It would also be interesting to disaggregate student data (beliefs and academic achievement) based on student ethnicity and/or socioeconomic status.
- The present research study gathered perceptions of mentoring efficacy and reports of mentoring practices; however, a stronger study would include the observation of mentoring practices. An interesting follow-up study would be to observe teachers as they mentor before and after they receive I-BPD. It would be interesting to note any changes in the types of activities that they use for mentoring. An additional source of data would be interviews with and questionnaires completed by protégés to determine their perceptions of the mentoring process and how it has impacted their teaching.

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APPENDICES

Appendix A - Project INQUIRE Syllabus

Project INQUIRE

Botany 531 – 3 credits, Spring/Summer 2003

INSTRUCTORS
Drs. Les Hickok (lhickok@utk.edu), Claudia Melear (ctmelear@utk.edu)
TEACHING ASSISTANT
Ms. Leslie Suters (lsuters@utk.edu)

Goal: Provide inquiry-based professional development opportunities for urban science teachers in order to increase confidence in mentoring novice and experienced science teachers to use the inquiry process and thus improve student achievement.

Course Intent: In order to effectively teach science, one must be able to DO science! This course is about doing science. It provides the opportunity to freely conduct hands-on investigative-based research with a living organism. Students will have ample opportunities to design and carry out experiments and will gain experience in the oral and written presentation of scientific data. Although this is not a course in "teaching methods", it will provide an opportunity to translate your experiences into the development of laboratory applications suitable for use in a K-12 classroom.

Expected Outcomes: Students will gain increased confidence in working cooperatively and with minimal supervision, enhanced critical thinking skills, familiarity with the 'real' processes of science, increased familiarity with the formal aspects of scientific research (data collection, analysis and presentation). Students will sharpen their ability to design scientifically sound experiments using a variety of organisms and approaches.

Required Materials: 1) A Laboratory-Inscription Notebook. This will be used to record all activities, experiments, calculations, data, etc. associated with individual and group research projects. Number pages (if needed) and date all entries. Copies of completed sections are to be handed in as called for (for periodic feedback) and the complete Notebook is to be handed in by the last date of the course. **2)** A 3.5" IBM formatted disc for course work to be handed in at the end of the semester

Organization: During the summer portion of the course, most class periods will involve collaborative and/or independent design, implementation and observation of experiments. Because experiments with living organisms typically do not limit themselves to our schedule (!!) it is expected that, as necessary, students will work in the lab outside of regular class hours. All participants will have open access to the lab room. Participants are expected to complete assigned readings throughout the course.

Presentations:

1. Journal Club Presentation – individual. Choose an interesting paper from current scientific periodicals (biology) and present a critical overview and analysis to the class, ca. 10 min. (oral with visuals and/or handouts). The chosen paper should contain original research, not a review or summary of previous work. (Due May 1)

2. Research Presentation on ‘unknown’ – individual or group of 2-3. Present a component(s) of the experimental work that you or your group have completed in your investigations of the ‘unknown’, ca. 15-30 min. (oral with visuals and a formal written research report in the format of a scientific paper). (Oral presentation and rough draft of research report Aug. 25; Final Draft of research report due Oct. 3)

3. Presentation of Inquiry-based Lessons - suitable for the grade(s) you teach – individual. This should be based on work with the organisms that you have learned to work and experiment with. The lessons should be derived from experiments that you have designed and carried out with the organisms. Additional information and guidelines will be provided as the course progresses. The lesson that you share with the class should be ones that you have had the opportunity to conduct with your own students. Student work samples as they completed the inquiries should be shared with the class. A science fair project board should be prepared to display one of your experiments/lessons. (Due Oct. 3)

Grading:

1. (15%) Participation and Reflective Journal – active participation in individual and cooperative activities and discussions throughout the course and upkeep and completion (hard copy and disc) of your personal Reflective Journal. (individual)
2. (15%) Laboratory-Inscription Notebook (individual)
3. (15%) Journal Club presentation. (individual)
4. (5%) Analysis of Teaching using STAM
5. (25%) Research presentation, oral and written. (individual or group)
6. (25%) Inquiry exercises and lessons. (individual)

Notes about Reflective Journals: Part of the grade for the course will be determined by your weekly reflections. Use any of the following topics in any order, in any frequency you wish:

How do you feel about the course, so far?
What frustrations, if any, are you experiencing?
How are groups forming, if any?
How much do you understand about what you are supposed to be doing?
Is this course similar/dissimilar to previous science courses/experiences?
What is the nature of scientific thinking, and specifically, yours?
How is your own scientific thinking developing?
What is scientific thinking?
What is the nature of science?
How would you use the information that you are learning to mentor novice (or experienced) teachers to use the inquiry process as a part of their teaching?
How would you apply what you are learning in your own classroom?

Date	**Time**	**Place**	**Topic**
April 17, 2003	4:30-7:30	Teacher Center	• Introduction • Discuss National Science Education and the State of TN standards for inquiry-based learning • Distribute textbooks • Setup aquarium
May 1	4:30-7:30	Teacher Center	• Journal club oral presentations • Video Analysis – Take home
May 15	4:30-7:30	Teacher Center	• Setup & conduct inquiry-based experiments with choice of one of the following: Pillbugs, or mealworms - participants will continue to conduct experiments with their chosen organism on their own over the month (take-home supplies).
June 9	1:30-4:30	UT - White Avenue Biology Annex (WBA) - 118	*Summer Course Portion* • Discussion of May inquiry experiments • Introduction and experimentation with Unknown Organism (June 9 - June 27) • Discuss developing Inquiry Lessons for classroom and methods for mentoring other teachers on using inquiry (June 25)
June 11	1:30-4:30		
June 13	1:30-4:30		
June 16	1:30-4:30		
June 18	1:30-4:30		
June 20	1:30-4:30		
June 23	1:30-4:30		
June 25	1:30-4:30		
June 27	1:30-4:30		
August 4	1:30-4:30	Teacher Center	• Discussion of experimentation with aquarium, pillbugs/mealworms, and unknowns. • Initial plans for mentoring within schools
August 25	4:30-7:30	Teacher Center	• Oral Research Presentations on choice of Unknown; 1st written draft due
Oct. 3	8:00-4:00	Teacher Center	• Final Presentation of Unknowns • Presentation of inquiry-based exercises – (written and oral); also include student work samples - Science Fair Format • Development of plan for mentoring teachers at schools in using inquiry-based methods as part of their mentor-core team responsibilities. • Post-class interviews/surveys

Total contact hours: 50

Appendix B - Participant Informed Consent Form

Informed Consent Form for Project INQUIRE course
Urban Impact, University of Tennessee - Knoxville

You are invited to participate in a research study. The purpose of this study is to determine the impact of the Project INQUIRE course. The primary goal of this course is to offer professional development opportunities designed to enhance your ability to conduct inquiry-based instruction within your classroom and to mentor novice teachers in these practices.

Your participation in this study may include the following:

1. Individual teacher interviews - The teachers will be interviewed before (March/April) and after (October) they participate in the course. The interviews will be audiotaped and transcribed; held at participant's school site; 45 minutes in duration, each

2. Observations of Teaching- Each participant will be observed and videotaped as he/she teaches class before (March/April) and after (Oct./Nov.) coursework. Video cameras will be focused only on the teacher and every effort will be made to not include students. Observations will occur over a week of instruction during a class specified by the participant (during science instruction for elementary teachers).

3. Completion of the following surveys/questionnaires on the first and last day of the Project INQUIRE course:
   - Science Teaching Efficacy Belief Instrument; 20 minutes (x 2)
   - Modified Nature of Scientific Knowledge Scale; 20 minutes (x 2)
   - Mentor Needs Questionnaire; 15 minutes (x 2)
   - Content Knowledge Questionnaire; 30-45 minutes (x 2)
   - Constructivist Learning Environment Survey; 30 minutes (x2)

4. Keeping a Reflective Journal - at least nine journal entries over the duration of the course; length should be approximately one and a half to two pages double-spaced. Time Requirement: variable

5. Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP) – administered March; 45 minutes

Risk of Participation

There is minimal risk involved in participating in this study. The only risk involved is the possible identification because of the use of videotaping of coursework and teaching. For these segments confidentiality and complete anonymity is not possible. However, you will be involved in adapting segments of the videotapes that will be used in formal presentations conducted by you or the researchers. If any children are captured on the videotape, the tapes will be altered in a manner that will not allow the children to be identified. You will have the opportunity to view the tapes and edit out anything you do not want included in the tapes. All participants will be fully aware of this before signing the informed consent form and participating in the study. Pseudonyms will be used in the transcriptions of the audiotapes of the individual interviews and the audiotapes will be erased after transcription.

Benefits
This study will provide specific information for *Urban Impact* in continuing to develop and refine both pre-service preparation initiatives and in-service induction practices in urban settings. It will also provide you with feedback to be used in refining your school's mentoring efforts. Furthermore, information gathered from this study will enable you to create professional development materials to be used in the induction process and to be shared with school systems across the state through the *Urban Impact* website. Specific benefits for participants include opportunities to network with other mentor teachers and to receive three hours of graduate school credit.

Confidentiality
The information in the study records will remain confidential and be stored securely. However, as stated, the information provided will be used as part of formal research presentations. Pseudonyms will be used when referring to your individual survey and questionnaire results in written reports. You will have opportunities to view and edit the videotapes taken throughout the Project INQUIRE course to create professional development materials. Direct reference to participants in the latter case will be unavoidable.

Contact
If you have questions at any time about the study or the procedures, you may contact the researcher, Leslie Suters at 421 Claxton Complex, phone number (865) 974-0502. If you have questions about your rights as a participant, contact the Compliance Section of the Office of Research at (865) 974-3466.

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

Consent
I have read the above information and agree to participate in this study. I have received a copy of this form.
Participant's name (print) ________________________

Participant's signature __________________________ Date ____________________

Consent to store videotape for up to 5 years to be used as material for formal conference presentations
Participant's signature _________________________ Date ____________________

Appendix C - Project INQUIRE Interview Protocol and Teacher's Pedagogical Philosophy Interview (TPPI) Coding

Project INQUIRE Interview Protocol

1. How would you describe yourself as a classroom teacher? (1)
2. What do you believe are your main strengths as a teacher? (39)
3. In what areas would you like to improve as a teacher? (40)
4. Describe the best teaching/learning situation that you have experienced. (21)
    a. In what way do you try to model that best teaching/learning situation in your classroom? (22)
    b. What are some of the impediments or constraints for implementing that kind of model in your classroom? (23)
    c. What are some of the tactics you use to overcome these constraints? (24)
5. How do you decide what to teach and what not to teach? (18)
6. How do you decide when to move from one concept to another? (19)
7. How do you know when your students understand a concept? (30)
8. How do you believe students learn best? (29)
9. In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)
10. When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13)
11. What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)
12. What science concepts do you believe are the most important for your students to understand by the end of the school year? (34)
13. What are some of the things that 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 ________________". (37)
14. Are there any things at the local/school/state/ levels that influence the way you teach? What are some examples of this? (25)
15. How do you accommodate students with special needs in your classroom? (38)
16. What is science? (14)
17. What are some of the things you value most about science? (28)

Extras (not from TPPI)

18. How would you define scientific inquiry?
19. Please describe an experience you have had learning/teaching by inquiry.

CODING SCHEME FOR TPPI

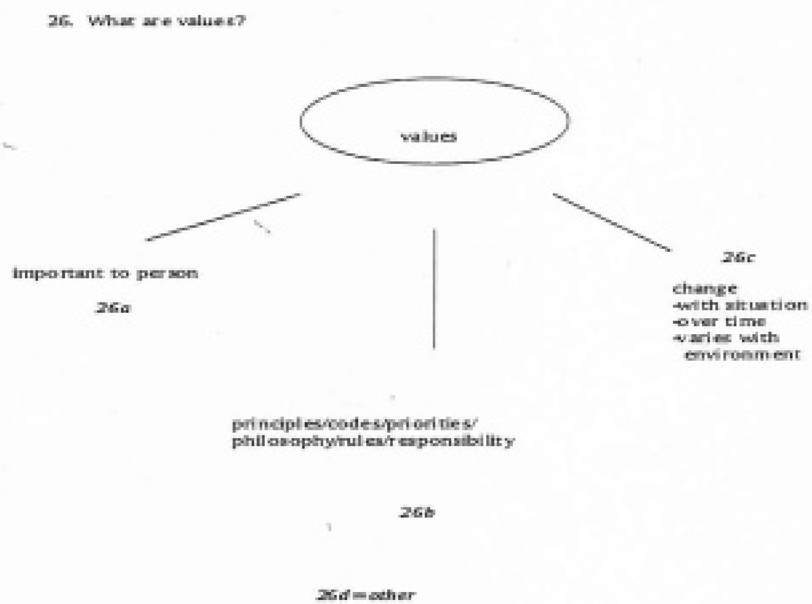
Format of the Coding Scheme

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.

<u>Level One Analysis</u>
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).

<u>Figure 1</u>

A sample TPPI coding map



<u>Level Two Analysis</u>

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 1.

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 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.

Appendix C.3 - TPPI Super Code Matrix

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,n,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		
	3a,e	3b,d,f-i		3c,j		

continued next page

	SUPERCODES					
TEACHER ACTIONS	**TADIDA**	**TATRAN**	**TACONC**	**TAEARL**	**TAEXPE**	
	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	
✓	23f-n,p			23a-e		
✓	24a,e,f		24c	24b		
✓	33b,k	33a,c,d,l	33f-h	33e,i,m		
STUDENT ACTIONS	**SADIDA**	**SATRAN**	**SACONC**	**SAEARL**		**SAINQU**
✓	29d,e,p	29c	29b,g,l,m,o	29f,h,i,k,n		
	31g,h	31i		31a-d,f		31k
✓	30a,c,h	30g	30b,d,e	30j		30i
	32a-d,f-h			32e		
	33b,k	33a,c,d,l	33f-h	33e,i,m		
	35a	35b,e-l,p	35c	35m,o		
	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**		
	23f-n,p			23a-e		
	24a,c,e,f			23b		
✓	25d,f-i			25e		

continued on next page

	SUPERCODES					
DIVERSITY	DIVDIDA	DIVTRAN	DIVCONC			
✓	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		
✓	21d,e,g,i,n,q,r			21 l,m,o,p		
✓	22e,g,h,k,q	22a,b,i,j	22f,l, p	22c,d,m	22n	
✓	29d,e,p	29c	29b,g,l,m,o	29f,h,i,k,n		
✓	30a,c,h	30g	30b,d,e	30j		30i

Appendix C.4 - TPPI Average Calculations by Participant and Question

Research Question 1 - Teacher Actions (TA) - Marie (T1)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you decide what to teach and what not to teach? (18) - Pre						Did not answer question.
(18) - Post						
How do you decide when to move from one concept to another? (19) - Pre					√	5
(19) - Post					√	5
What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23) - Pre						NA
(23) - Post						NA
What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24)						NA
(24) - Post						NA
In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)		√				2
(33) - Post				√		4
Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25)	√					1
(25) - Post				√		4
How do you accommodate students with special needs in your classroom? (38)			√			3
(38) - Post			√			3
Average TA Pre-Interview: 10/4						2.5
Average TA Post-Interview: 16/4						4

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question Two - Student Actions (SA) - Marie (T1)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you believe students learn best? (29) - Pre			√	√		3.5
(29) - Post			√	√		3.5
How do you know when your students understand a concept? (30) - Pre	√		√			2
(30) - Post	√		√	√		2.7
What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because _________________". (37) - Pre				√		4
(37) - Post				√		4
Average SA Pre-Interview: 9.5/3						3.2
Average SA Post-Interview: 10.2/3						3.4

Research Question Two - Teacher's Philosophy of Teaching (PT)

Question	A=1	B=2	C=3	D=4	E=5	Average
How would you describe yourself as a classroom teacher? (1) - Pre			√			3
(1) - Post			√			3
When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) - Pre	√			√		2.5
(13) - Post	√			√		2.5
What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)- Pre			√			3
(20) - Post			√	√		3.5
Describe the best teaching/learning situation that you have experienced. (21) - Pre				√		4
(21) - Post				√		4
In what way do you try to model that best teaching/learning situation in your classroom? (22) - Pre			√			3
(22) - Post			√			3
What do you believe are your main strengths as a teacher? (39) -Pre				√		4
(39) - Post				√		4
In what areas would you like to improve as a teacher? (40) - Pre				√		4
(40) - Post				√		4
Average PT Pre-Interview: 23.5/7						3.4
Average PT Post-Interview: 24/7						3.4

Research Question 3 - Teacher and Content (TC) - Marie (T1)

Question	A=1	B=2	C=3	D=4	E=5	Average
What is science? (14) - Pre	√					1
(14) - Post	√					1
What are some of the things you value most about science? (28) - Pre		√		√		3
(28) - Post		√		√		3
What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) - Pre			√			3
(34) - Post			√			3
Average TC Pre-Interview: 7/3						2.3
Average TC Post-Interview: 7/3						2.3

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question 1 - Teacher Actions (TA) - Tee Jay (T2)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you decide what to teach and what not to teach? (18) - Pre	√			√		2.5
(18) - Post	√			√		2.5
How do you decide when to move from one concept to another? (19) - Pre	√					1
(19) - Post	√					1
What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23) - Pre	√			√		2.5
(23) - Post	√			√		2.5
What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24)	√					1
(24) - Post	√					1
In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)		√				2
(33) - Post		√				2
Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25)	√					1
(25) - Post			√			3
How do you accommodate students with special needs in your classroom? (38)			√			3
(38) - Post	√		√			2
Average TA Pre-Interview: 13/7						1.9
Average TA Post-Interview: 14/7						2.0

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question Two - Student Actions (SA) - Tee Jay (T2)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you believe students learn best? (29) - Pre				√		4
(29) - Post				√		4
How do you know when your students understand a concept? (30) - Pre	√					1
(30) - Post	√	√	√			2
What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because _________________". (37) - Pre				√		4
(37) - Post				√		4
Average SA Pre-Interview: 9/3						3
Average SA Post-Interview: 10/3						3.3

Research Question Two - Teacher's Philosophy of Teaching (PT)

Question	A=1	B=2	C=3	D=4	E=5	Average
How would you describe yourself as a classroom teacher? (1) - Pre	√					1
(1) - Post			√			3
When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) - Pre				√		4
(13) - Post				√		4
What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)- Pre				√		4
(20) - Post			√	√		3.5
Describe the best teaching/learning situation that you have experienced. (21) - Pre				√		4
(21) - Post				√		4
In what way do you try to model that best teaching/learning situation in your classroom? (22) - Pre			√			3
(22) - Post			√			3
What do you believe are your main strengths as a teacher? (39) -Pre	√					1
(39) - Post	√					1
In what areas would you like to improve as a teacher? (40) - Pre	√					1
(40) - Post	√					1
Average PT Pre-Interview: 18/7						2.6
Average PT Post-Interview: 19.5/7						2.8

Research Question 3 - Teacher and Content (TC) - Tee Jay (T2)

Question	A=1	B=2	C=3	D=4	E=5	Average
What is science? (14) - Pre	√					1
(14) - Post	√					1
What are some of the things you value most about science? (28) - Pre	√					1
(28) - Post	√			√		2.5
What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) - Pre	√			√		2.5
(34) - Post	√			√		2.5
Average TC Pre-Interview: 4.5/3						1.5
Average TC Post-Interview: 6/3						2.0

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question 1 - Teacher Actions (TA) - Daphne (T3)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you decide what to teach and what not to teach? (18) - Pre	√	√			√	2.7
(18) - Post	√	√	√		√	2.8
How do you decide when to move from one concept to another? (19) - Pre		√				2
(19) - Post		√				2
What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23) - Pre				√		4
(23) - Post				√		4
What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24)	√			√		2.5
(24) - Post	√			√		2.5
In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)		√				2
(33) - Post		√	√			2.5
Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25)	√		√	√		2.7
(25) - Post	√		√	√		2.7
How do you accommodate students with special needs in your classroom? (38)			√			3
(38) - Post			√			3
Average TA Pre-Interview: 18.9/7						2.7
Average TA Post-Interview: 19.5/7						2.8

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question Two - Student Actions (SA) - Daphne (T3)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you believe students learn best? (29) - Pre				√		4
(29) - Post				√		4
How do you know when your students understand a concept? (30) - Pre		√	√			2.5
(30) - Post		√	√			2.5
What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because _________________". (37) - Pre				√		4
(37) - Post				√		4
Average SA Pre-Interview: 10.5/3						3.5
Average SA Post-Interview: 10.5/3						3.5

Research Question Two - Teacher's Philosophy of Teaching (PT)

Question	A=1	B=2	C=3	D=4	E=5	Average
How would you describe yourself as a classroom teacher? (1) - Pre				√		4
(1) - Post				√		4
When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) - Pre				√		4
(13) - Post				√		4
What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)- Pre			√			3
(20) - Post			√	√		3.5
Describe the best teaching/learning situation that you have experienced. (21) - Pre				√		4
(21) - Post				√		4
In what way do you try to model that best teaching/learning situation in your classroom? (22) - Pre				√		4
(22) - Post				√		4
What do you believe are your main strengths as a teacher? (39) -Pre				√		4
(39) - Post				√		4
In what areas would you like to improve as a teacher? (40) - Pre	√					1
(40) - Post	√					1
Average PT Pre-Interview: 24/7						3.4
Average PT Post-Interview: 24.5/7						3.5

Research Question 3 - Teacher and Content (TC) - Daphne (T3)

Question	A=1	B=2	C=3	D=4	E=5	Average
What is science? (14) - Pre	√					1
(14) - Post	√					1
What are some of the things you value most about science? (28) - Pre		√				2
(28) - Post		√				2
What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) - Pre			√			3
(34) - Post				√		4
Average TC Pre-Interview: 6/3						2.0
Average TC Post-Interview: 7/3						2.3

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question 1 - Teacher Actions (TA) - Shannon (T4)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you decide what to teach and what not to teach? (18) - Pre	√					1
(18) - Post	√					1
How do you decide when to move from one concept to another? (19) - Pre					√	5
(19) - Post		√			√	3.5
What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23) - Pre	√					1
(23) - Post	√					1
What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24)			√			3
(24) - Post			√			3
In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)		√		√		3
(33) - Post		√		√		3
Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25)			√			3
(25) - Post			√			3
How do you accommodate students with special needs in your classroom? (38)		√				2
(38) - Post		√				2
Average TA Pre-Interview: 18/7						2.6
Average TA Post-Interview: 16.5/7						2.4

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question Two - Student Actions (SA) - Shannon (T4)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you believe students learn best? (29) - Pre		√	√			2.5
(29) - Post		√	√			2.5
How do you know when your students understand a concept? (30) - Pre		√	√			2.5
(30) - Post		√	√			2.5
What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because ________________". (37) - Pre				√		4
(37) - Post				√		4
Average SA Pre-Interview: 9/3						3
Average SA Post-Interview: 9/3						3

Research Question Two - Teacher's Philosophy of Teaching (PT)

Question	A=1	B=2	C=3	D=4	E=5	Average
How would you describe yourself as a classroom teacher? (1) - Pre			√			3
(1) - Post			√			3
When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) - Pre	√			√		2.5
(13) - Post	√			√		2.5
What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)- Pre			√			3
(20) - Post			√			3
Describe the best teaching/learning situation that you have experienced. (21) - Pre	√			√		2.5
(21) - Post	√			√		2.5
In what way do you try to model that best teaching/learning situation in your classroom? (22) - Pre			√			3
(22) - Post			√			3
What do you believe are your main strengths as a teacher? (39) -Pre				√		4
(39) - Post				√		4
In what areas would you like to improve as a teacher? (40) - Pre	√			√		2.5
(40) - Post	√			√		2.5
Average PT Pre-Interview: 20.5/7						2.9
Average PT Post-Interview: 20.5/7						2.9

Research Question 3 - Teacher and Content (TC) - Shannon (T4)

Question	A=1	B=2	C=3	D=4	E=5	Average
What is science? (14) - Pre	√					1
(14) - Post	√					1
What are some of the things you value most about science? (28) - Pre		√		√		3
(28) - Post		√		√		3
What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) - Pre			√	√		3.5
(34) - Post			√	√		3.5
Average TC Pre-Interview: 7.5/3						2.5
Average TC Post-Interview: 7.5/3						2.5

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question 1 - Teacher Actions (TA) - Laura (T5)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you decide what to teach and what not to teach? (18) - Pre	√	√				1.5
(18) - Post	√	√			√	2.7
How do you decide when to move from one concept to another? (19) - Pre		√				2
(19) - Post		√	√			2.5
What are some of the impediments or constraints to implementing that kind of model in your classroom? (reference to best learning/teaching situation experienced) (23) - Pre	√		√			2
(23) - Post	√		√			2
What are some of the tactics you use to overcome these constraints? (reference to best learning/teaching situation experienced) (24)				√	√	4.5
(24) - Post				√	√	4.5
In what ways do you manipulate the educational environment (classroom, school, etc.) to maximize student understanding? (33)				√		4
(33) - Post				√		4
Are there any things at the local/school/state levels that influence the way you teach? What are some examples of this? (25)	√					1
(25) - Post	√					1
How do you accommodate students with special needs in your classroom? (38)						Question skipped in pre-interview
(38) - Post			√		√	4
Average Pre-Interview: 15/6						2.5
Average Post-Interview: 20.7/7						3.0

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Research Question Two - Student Actions (SA) - Laura (T5)

Question	A=1	B=2	C=3	D=4	E=5	Average
How do you believe students learn best? (29) - Pre			√	√		3.5
(29) - Post			√	√		3.5
How do you know when your students understand a concept? (30) - Pre	√		√			2
(30) - Post	√		√			2
What are some of the things that you believe your students value most about their educational experience in your classroom? When they leave here they say, "I really liked (her) class because ________________". (37) - Pre				√		4
(37) - Post				√		4
Average SA Pre-Interview: 9.5/3						3.2
Average SA Post-Interview: 9.5/3						3.2

Research Question Two - Teacher's Philosophy of Teaching (PT)

Question	A=1	B=2	C=3	D=4	E=5	Average
How would you describe yourself as a classroom teacher? (1) - Pre					√	5
(1) - Post					√	5
When you picture a good learner in your mind, what characteristics of that person lead you to believe that they are a good learner? (13) - Pre					√	5
(13) - Post					√	5
What learning in your classroom do you think will be valuable to your students outside the classroom environment? (20)- Pre				√		4
(20) - Post				√		4
Describe the best teaching/learning situation that you have experienced. (21) - Pre					√	5
(21) - Post					√	5
In what way do you try to model that best teaching/learning situation in your classroom? (22) - Pre				√		4
(22) - Post				√		4
What do you believe are your main strengths as a teacher? (39) -Pre				√		4
(39) - Post				√	√	4.5
In what areas would you like to improve as a teacher? (40) - Pre				√		4
(40) - Post				√	√	4.5
Average PT Pre-Interview: 31/7						4.4
Average PT Post-Interview: 32/7						4.6

Research Question 3 - Teacher and Content (TC) - Laura (T5)

Question	A=1	B=2	C=3	D=4	E=5	Average
What is science? (14) - Pre	√					1
(14) - Post	√					1
What are some of the things you value most about science? (28) - Pre		√				2
(28) - Post		√				2
What science concepts do you believe are the most important for your students to understand by the end of the school year? (34) - Pre			√	√		3.5
(34) - Post			√	√		3.5
Average TC Pre-Interview: 6.5/3						2.2
Average TC Post-Interview: 6.5/3						2.2

A=Didactic, 1; B=Transitional, 2; C=Conceptual, 3; D=Early Constructivist, 4; E=Experienced Constructivist, 5

Appendix D- Secondary Teacher Analysis Matrix (STAM)

Secondary Science Teacher Analysis Matrix © Revised, August 1995
J. Gallagher and J. Parker 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

Appendix D.2 - STAM Analysis Matrix

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

Secondary Science Teaching Analysis Matrix
J. Gallagher & J. Parker
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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

ıcondary Science Teaching Analysis Matrix
Gallagher & J. Parker
ıy 1995 © Revised August 1995

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

Appendix D.3 - STAM Analysis Template and Video Portfolio

Teacher:__________________ **Coders:** ____________________
Topic: ____________________ ____________________

SUMMARY OF VIDEO PORTFOLIO

Activity/Transition Timeline

DATE	TAPE	A OR T	START TIME	DESCRIPTION
	1	1T1	0:00	
		1A1		

Teacher:__________________ **Coders:** ____________________
Topic: ____________________ ____________________

SUMMARY OF VIDEO PORTFOLIO

OVERVIEW:

CONTENT:

TEACHER’S ACTIONS:

STUDENT’S ACTIONS:

RESOURCES:

ENVIRONMENT:

OTHER:

Appendix E - Salish Inventory for Demographic Evaluation of Schools and Teacher Education Programs (SIDESTEP) - Part II

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 ______________________

# of years Teaching ______ Degrees ______ Place

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): ______________________________

Grade Level – Elementary (2-5)

Grade Level ____
Please List subjects you are responsible for teaching below:

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 use to address gender equity issues in your classes?

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 use to address these special needs (if applicable)?

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

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. (Related to science)

_____	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 Discplayers (1) _____ Other: __________
CD-ROM (2) _____
Modem (3) _____
(or another internet connection)

(science)

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. __________

____

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

_____ NO (0) _____ YES (1)

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)

For Elementary: How many of those hours are spent preparing for science? _____

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

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

17. List in order your top three goals for your students' learning: (related to science)

Most important:

Second most important:

Third most important:

Optional 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	$________

Appendix F - Constructivist Learning Environment Survey (CLES)

Salish I Research Project
Constructivist Learning Environment Survey[8]
Science Teacher Form

Date ______________________ Teacher Name ______________________

School ______________________ Course Title ______________________

Directions: For each statement, fill in the circle that best describes your feelings about the class that was videotaped. Please consider each item carefully and answer every item.

	In this class ...	Almost Always	Often	Sometimes	Seldom	Almost Never
1.	Students learn about the world outside of school.	0	0	0	0	0
2.	Students learn that scientific theories are human inventions.	0	0	0	0	0
3.	It's OK for students to ask "Why do we have to learn this?"	0	0	0	0	0
4.	Students help me to plan what they are going to learn.	0	0	0	0	0
5.	Students get the chance to talk to each other.	0	0	0	0	0
6.	Students look forward to the learning activities.	0	0	0	0	0
7.	New learning starts with problems about the world outside of school.	0	0	0	0	0
8.	Students learn that science is influenced by people's values and opinions.	0	0	0	0	0
9.	Students feel free to question the way they are being taught.	0	0	0	0	0
10.	Students help the teacher decide how well their learning is going.	0	0	0	0	0
11.	Students talk with each other about how to solve problems.	0	0	0	0	0
12.	The activities are among the most interesting at this school.	0	0	0	0	0

(continued)

[8]Adapted from *Constructivist Learning Environment Survey*, P. Taylor, B. Fraser, & L. White, Curtin University of Technology

	In this class ...	Almost Always	Often	Sometimes	Seldom	Almos Never
13.	Students learn how science can be a part of their out-of-school life.	0	0	0	0	0
14.	Students learn that the views of science have changed over time.	0	0	0	0	0
15.	It's OK for students to complain about activities that are confusing.	0	0	0	0	0
16.	Students have a say in deciding the rules for classroom discussion.	0	0	0	0	0
17.	Students try to make sense of each other's ideas.	0	0	0	0	0
18.	The activities make students interested in science.	0	0	0	0	0
19.	Students get a better understanding of the world outside of school.	0	0	0	0	0
20.	Students learn that different sciences are used by people in other cultures.	0	0	0	0	0
21.	It's OK for students to complain about anything that stops them from learning.	0	0	0	0	0
22.	Students have a say in deciding how much time they spend on an activity.	0	0	0	0	0
23.	Students ask each other to explain their ideas.	0	0	0	0	0
24.	Students enjoy the learning activities.	0	0	0	0	0
25.	Students learn interesting things about the world outside of school.	0	0	0	0	0
26.	Students learn that scientific knowledge can be questioned.	0	0	0	0	0
27.	Students are free to express their opinions.	0	0	0	0	0
28.	Students offer to explain their ideas to one another.	0	0	0	0	0
29.	Students feel confused.	0	0	0	0	0

	In this class ...	Almost Always	Often	Sometimes	Seldom	Almost Never
30.	What students learn has nothing to do with their out-of-school life.	0	0	0	0	0
31.	Students learn that science reveals the secrets of nature.	0	0	0	0	0
32.	It's OK for students to speak up for each other's rights.	0	0	0	0	0
33.	Students have a say in deciding what will be on the test.	0	0	0	0	0
34.	Students explain their ideas to each other.	0	0	0	0	0
35.	The learning activities are a waste of time.	0	0	0	0	0
36.	Students have a say in deciding what activities they do.	0	0	0	0	0
37.	What students learn has nothing to do with the world outside of school.	0	0	0	0	0
38.	Students learn that scientific knowledge is beyond doubt.	0	0	0	0	0
39.	Students feel unable to complain about anything.	0	0	0	0	0
40.	Students have a say in deciding <u>how</u> their learning is assessed.	0	0	0	0	0
41.	Students pay attention to each other's ideas.	0	0	0	0	0
42.	Students feel tense.	0	0	0	0	0

Appendix F.2 - CLES: Scoring Instructions

Salish Research Project
Constructivist Learning Environment Survey
Scoring Guidelines for the Science Teacher Form, 1994-1995 Version

This instrument consists of both positive and negative statements which teachers must answer on a scale that ranges from "Almost Always" to "Almost Never." For **positive** item statements, the "Almost Always" choice would receive a 5 moving on down to the "Almost Never" choice which would receive a 1. For **negative** item statements, the numbering procedure is reversed.

Example:

		Almost Always	Often	Sometimes	Seldom	Almost Never
	In this class...					
(+)1.	students learn about the world outside of school.	0 5	X 4	0 3	0 2	0 1
(-)2.	what students learn has nothing to do with the world outside of school.	0 1	X 2	0 3	0 4	0 5

Sample item one would be scored as a 4 while sample item two would be scored as a 2. The total score would be 4 + 2 = 6, in this example.

I. PERSONAL RELEVANCE SCALE (PR)

This scale is concerned with students' experience of the personal relevance of school science as perceived by teachers. The scale has been designed to measure the extent to which teachers feel that their students perceive the relevance of school science to their out-of-school lives. From a constructivist perspective, the classroom environment should not promote a discontinuity between school science and students' out-of-school lives by evoking an abstract and decontextualized image of science. Rather, the classroom environment should engage students in opportunities:
(1) to experience the relevance of school science to their everyday interests and activities;
(2) to use their everyday experiences as a meaningful context for the development of their formal scientific knowledge.

Items:

1.	(+)	30.	(-)
7.	(+)	37.	(-)
13.	(+)		
19.	(+)		
25.	(+)		

II. SCIENTIFIC UNCERTAINTY SCALE (SU)

This scale is concerned with students' perceptions of science as a fallible human activity as perceived by teachers. The scale has been designed to measure the extent to which teachers feel that their students perceive science to be an uncertain and evolving activity embedded in a cultural context and embodying human values and interests. From a constructivist perspective, the classroom environment should not promote: (1) a *scientistic view* of science as a supreme universal mono-cultural activity that is independent of human interests and values; or (2) the *objectivist* myth that science provides an accurate and certain representation of objective reality (i.e., a correspondence theory of truth). Rather, the classroom environment should be concerned with engaging students in opportunities to learn to be skeptical and critical about the nature and value of science. In particular, to learn:
(1) that scientific knowledge is evolving and provisional;
(2) that scientific knowledge is shaped by social and cultural influences;
(3) that scientific knowledge arises from human interests and values.

Items:

2.	(+)	31.	(-)
8.	(+)	38.	(-)
14.	(+)		
20.	(+)		
26.	(+)		

III. CRITICAL VOICE SCALE (CV)

This scale is concerned with students' development as autonomous learners. In particular, the scale has been designed to measure teachers' assessment of students' perceptions of the extent to which they are able to exercise legitimately a *critical voice* about the quality of their learning activities. From a constructivist perspective, the classroom environment should not favor technica curriculum interests (e.g., *covering the curriculum content)* to an extent that accountability for classroom activities is directed largely towards an external authority. Rather, the teacher should be willing to demonstrate his/her accountability to the class by fostering students' critical attitudes towards the teaching and learning activities. This can be achieved by creating a social climate in which students feel that it is legitimate and beneficial:
(1) to question the teacher's pedagogical plans and methods;
(2) to express concerns about any impediments to their learning.

Items:

3.	(+)	39.	(-)
9.	(+)		
15.	(+)		
21.	(+)		
27.	(+)		
32.	(+)		

IV. SHARED CONTROL SCALE (SC)

This scale is concerned with another important aspect of the development of student autonomy, namely students sharing with their teachers control of the classroom learning environment. In particular, the scale has been designed to measure the extent to which the teacher involves students in the *management* of the classroom learning environment. From a constructivist perspective, students should not be required to adopt the traditional role of compliant recipients of a predetermined pedagogy that is controlled entirely by the teacher. Rather, the teacher should invite students to share control of important aspects of their learning by providing opportunities for them to participate in the processes of:
(1) designing and managing their own learning activities;
(2) determining and applying assessment criteria,
(3) negotiating the social norms of the classroom.

Items:

4. (+)
10. (+)
16. (+)
22. (+)
33. (+)
36. (+)
40. (+)

V. STUDENT NEGOTIATION SCALE (SN)

This scale is concerned with negotiation amongst students as perceived by teachers. The scale has been designed to measure teachers' beliefs concerning students' perceptions of the extent to which they interact verbally with other students for the purpose of building their scientific knowledge within the consensual domain of the classroom. From a constructivist perspective, the classroom environment should not require students to learn in social isolation from other students or to regard the teacher or textbook as the main arbiter of what counts as viable scientific knowledge. Rather, the classroom environment should be concerned with engaging students in opportunities:
(1) to explain and justify their newly developing ideas to other students;
(2) to make sense of other students' ideas and reflect on the viability of their ideas;
(3) to reflect critically on the viability of their own ideas.

Items:

5. (+)
11. (+)
17. (+)
23. (+)
28. (+)
34. (+)
41. (+)

Constructivist Learning Environment Survey
Scoring Guidelines - Science Teacher Form
Page Four

VI. ATTITUDE SCALE (AT)

This scale has been included to provide a measure of the concurrent validity of the CLES. The attitude scale has been used extensively in research on science laboratory classes, and has an established reliability. The scale measures teachers' interpretations of student attitudes to important aspects of the classroom environment, including:
(1) their anticipation to the activities;
(2) their sense of worthwhileness of the activities;
(3) the impact of the activities on student interest, enjoyment and understanding.

Items:

6.	(+)	29.	(-)
12.	(+)	35.	(-)
18.	(+)	42.	(-)
24.	(+)		

For the purposes of this study, subscale scores were divided into categories for analysis.

Scores:
7-13 = Low agreement with scale
14-20 = Low intermediate agreement with scale
21-27 = High intermediate agreement with scale
28-35 + High agreement with scale

Appendix F.3 - CLES Scores: Participant Calculation.

Personal Relevance Scale (PR)

		Marie		Tee Jay		Daphne		Shannon		Laura	
1	p	O	4	O	4	AA	5	SO	3	AA	5
7	p	O	4	SO	3	SO	3	SO	3	AA	5
13	p	AA	5	O	4	SO	3	SO	3	AA	5
19	p	O	4	O	4	SO	3	O	4	AA	5
25	p	O	4	O	4	SE	2	SO	3	AA	5
30	n	AN	5	SE	4	SE	4	AN	5	SE	4
37	n	AN	5	AN	5	AN	5	AN	5	AN	5
Sum			31		28		25		26		34

Scientific Uncertainty Scale (SU)

		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	SO	3	SE	2	SE	2	SO	3	AA	5
8	p	O	4	SO	3	SO	3	SO	3	AA	5
14	p	SO	3	O	4	O	4	SE	2	AA	5
20	p	SO	3	SO	3	SE	2	AN	1	SO	3
26	p	O	4	O	4	SO	3	O	4	AA	5
31	n	SO	3	SO	3	O	2	SO	3	AA	1
38	n	SE	4	SE	4	SE	4	SO	3	AN	5
Sum			24		23		20		19		29
Percent			0.686		0.6571		0.57		0.54		0.83

Critical Voice Scale (CV)

		Marie		Tee Jay		Daphne		Shannon		Laura	
3	p	SO	3	O	4	O	4	O	4	AA	5
9	p	O	4	O	4	O	4	SE	2	AA	5
15	p	SO	3	O	4	SE	2	SO	3	AA	5
21	p	AN	1	O	4	SE	2	SO	3	AA	5
27	p	SO	3	O	4	O	4	O	4	AA	5
32	p	SO	3	O	4	O	4	O	4	AA	5
39	n	SE	4	SE	4	O	2	SE	4	AN	5
Sum			21		28		22		24		35

Shared Control Scale (SC)

		Marie		Tee Jay		Daphne		Shannon		Laura	
4	p	O	4	SO	3	SO	3	O	4	O	4
10	p	AN	1	SO	3	SO	3	AA	5	AA	5
16	p	O	4	SO	3	O	4	O	4	AA	5
22	p	SO	3	SO	3	SO	3	SE	2	O	4
33	p	SO	3	SE	2	SE	2	AN	1	?	0

36	p	O	4	SO	3	SO	3	AN	1	O	4
40	p	SO	3	SE	2	O	4	AN	1	O	4
Sum			22		19		22		18		26

Student Negotiation Scale (SN)

		Marie		Tee Jay		Daphne		Shannon		Laura	
5	p	O	4	O	4	O	4	O	4	AA	5
11	p	O	4	O	4	SO	3	O	4	AA	5
17	p	O	4	SO	3	SE	2	O	4	AA	5
23	p	SO	3	O	4	O	4	O	4	O	4
28	p	O	4	O	4	O	4	O	4	O	4
34	p	O	4	O	4	SO	3	SO	3	AA	5
41	p	SE	2	SE	2	AA	5	SO	3	O	4
Sum			25		25		25		26		32

Attitude Scale (AT)

		Marie		Tee Jay		Daphne		Shannon		Laura	
6	p	AA	5	O	4	O	4	SO	3	AA	5
12	p	O	4	O	4	SE	2	SO	3	AA	5
18	p	AA	5	O	4	SO	3	AA	5	AA	5
24	p	AA	5	O	4	SO	3	O	4	AA	5
29	n	O	2	SE	4	SO	3	SO	3	O	2
35	n	AN	5	SE	4	AN	5	SO/SE	3.5	AN	5
42	n	AN	5	SE	4	SE	4	SE	4	SO	3
Sum			31		28		24		25.5		30

Total Possible for each section - 35

	p	n	
Almost Always	5	1	A
Often	4	2	
Sometimes	3	3	
Seldom	2	4	
Almost Never	1	5	

	T1	T2	T3	T4	T5
PR	31	28	25	26	34
SU	24	23	20	19	29
CV	21	28	22	24	35
SC	22	19	22	18	26
SN	25	25	25	26	32
AT	31	28	24	25.5	30
TOTAL (210)	154	151	138	138.5	186

Constructivist Learning Environment Survey - Post-Assessment 10/03

Personal Relevance Scale (PR)

		Marie		Tee Jay		Daphne		Shannon		Laura	
1	p	AA	5	O	4	O	4	SO	3	AA	5
7	p	AA	5	O	4	SO	3	SE	2	O	4
13	p	AA	5	O	4	SO	3	SO	3	AA	5
19	p	AA	5	AA	5	SO	3	AA	5	AA	5
25	p	AA	5	O	4	SE	2	SO	3	AA	5
30	n	SO	4	SE	4	AN	5	SE	4	AN	5
37	n	SO	4	SE	4	SE	4	SE	4	AN	5
Sum			33		29		24		24		34

Scientific Uncertainty Scale (SU)

		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	SO	3	SO	3	AN	1	O	4	O	4
8	p	SO	3	O	4	SE	2	SO	3	AA	5
14	p	AA	5	AA	5	AN	1	O	4	O	4
20	p	O	4	SO	3	AN	1	SO	3	O	4
26	p	O	4	O	4	AN	1	SO	3	AA	5
31	n	O	2	O	2	SO	3	SO	3	O	2
38	n	SO	3	SE	4	AN	5	O	2	AN	5
Sum			24		25		14		22		29

Critical Voice Scale (CV)

		Marie		Tee Jay		Daphne		Shannon		Laura	
3	p	SO	3	AA	5	SO	3	SE	2	AA	5
9	p	O	4	AA	5	O	4	SO	3	AA	5
15	p	O	4	AA	5	SE	2	SO	3	AA	5
21	p	AN	1	O	4	SE	2	SO	3	AA	5
27	p	O	4	O	4	SO	3	SO	3	AA	5
32	p	O	4	O	4	O	4	O	4	AA	5
39	n	SE	4	SE	4	SE	4	O	2	AN	5
Sum			24		31		22		20		35

Shared Control Scale (SC)

		Marie		Tee Jay		Daphne		Shannon		Laura	
4	p	AA	5	AA	5	O	4	SE	2	O	4
10	p	O	4	O	4	SO	3	O	4	AA	5
16	p	O	4	O	4	SO	3	AA	5	O	4
22	p	O	4	SO	3	SE	2	SE	2	O	4
33	p	O	4	O	4	SE	2	SE	2	O	4
36	p	SO	3	O	4	SO	3	SE	2	SO	3
40	p	SE	2	O	4	SE	2	SE	2	O	4
Sum			26		28		19		19		28

Student Negotiation Scale (SN)

		Marie		Tee		Daphne		Shannon		Laura	

				Jay							
5	p	O	4	AA	5	O	4	O	4	AA	5
11	p	O	4	AA	5	O	4	O	4	AA	5
17	p	O	4	O	4	SE	2	O	4	AA	5
23	p	O	4	O	4	SO	3	O	4	AA	5
28	p	AA	5	AA	5	SO	3	SO	3	AA	5
34	p	O	4	AA	5	SO	3	SO	3	AA	5
41	p	O	4	O	4	SO	3	SE	2	AA	5
Sum			29		32		22		24		35

Attitude Scale (AT)

		Marie		Tee Jay		Daphne		Shannon		Laura	
6	p	AA	5	O	4	O	4	SO	3	AA	5
12	p	O	4	O	4	SO	3	O	4	AA	5
18	p	AA	5	O	4	O	4	AA	5	AA	5
24	p	AA	5	O	4	O	4	AA	5	AA	5
29	n	SO	3	SE	4	SE	4	SO	3	O	2
35	n	AN	5	SE	4	AN	5	SE	4	AN	5
42	n	SE	4	SE	4	AN	5	O	2	SO	3
Sum			31		28		29		26		30

	T1	T2	T3	T4	T5
PR	33	29	24	24	34
SU	24	25	14	22	29
CV	24	31	22	20	35
SC	26	28	19	19	28
SN	29	32	22	24	35
AT	31	28	29	26	30
TOTAL (210)	167	173	130	135	191

Appendix G- Science Teaching Efficacy Belief Instrument (STEBI)

Appendix G.1 - STEBI: Instrument

Science Teaching Efficacy Belief Instrument*

lease indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the ght of each statement.

SA = Strongly Agree
A = Agree
UN = Uncertain
D = Disagree
SD = Strongly Disagree

1.	When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	SA A UN D SD
2.	I am continually finding better ways to teach science.	SA A UN D SD
3.	Even when I try very hard, I don't teach science as well as I do most subjects.	SA A UN D SD
4.	When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	SA A UN D SD
5.	I know the steps necessary to teach science concepts effectively.	SA A UN D SD
6.	I am not very effective in monitoring science experiments.	SA A UN D SD
7.	If students are underachieving in science, it is most likely due to ineffective science teaching.	SA A UN D SD
8.	I generally teach science ineffectively.	SA A UN D SD
9.	The inadequacy of a student's science background can be overcome by good teaching.	SA A UN D SD
10.	The low science achievement of some students cannot generally be blamed on their teachers.	SA A UN D SD
11.	When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.	SA A UN D SD
12.	I understand science concepts well enough to be effective in teaching elementary science.	SA A UN D SD
13.	Increased effort in science teaching produces little change in some students' science achievement.	SA A UN D SD
14.	The teacher is generally responsible for the achievement of students in science.	SA A UN D SD
15.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	SA A UN D SD
16.	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	SA A UN D SD
17.	I find it difficult to explain to students why science experiments work.	SA A UN D SD
18.	I am typically able to answer students' science questions.	SA A UN D SD
19.	I wonder if I have the necessary skills to teach science.	SA A UN D SD
20.	Effectiveness in science teaching has little influence on the achievement of students with low motivation.	SA A UN D SD
21.	Given a choice, I would not invite the principal to evaluate my science teaching.	SA A UN D SD
22.	When a student has difficulty understanding a science concept, I am usually at a loss as to how to help the student understand it better.	SA A UN D SD
23.	When teaching science, I usually welcome student questions.	SA A UN D SD
24.	I don't know what to do to turn students on to science.	SA A UN D SD
25.	Even teachers with good science teaching abilities cannot help some kids learn science.	SA A UN D SD

n Riggs, I., & Knochs, L. (1990). Towards the development of an elementary teacher's science teaching efficacy belief strument. *Science Education, 74*, 625-637.

Appendix G.2 - STEBI: Scoring Instructions and Calculations

STEBI - Pre-Assessment 4/17/03

Personal Science Teaching Efficacy Belief Scale

Question		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	SA	5	SA	5	A	4	A	4	A	4
3	n	D	4	D	4	SA	1	SD	5	SD	5
5	p	A	4	A	4	SD	1	D	2	A	4
6	n	D	4	D	4	A	2	SA	1	SD	5
8	n	D	4	D	4	SA	1	D	4	SD	5
12	p	A	4	A	4	D	2	A	4	SA	5
17	n	D	4	D	4	A	2	D	4	SD	5
18	p	A	4	A	4	A	4	D	2	A	4
19	n	D	4	D	4	A	2	D	4	SD	5
21	n	D	4	D	4	A	2	SD	5	SD	5
22	n	D	4	D	4	A	2	D	4	SD	5
23	p	A	4	A	4	A	4	SA	5	SA	5
24	n	D	4	D	4	SA	1	SD	5	SD	5
65 possible			53		53		28		49		62

Outcome Expectancy

Question		Marie		Tee Jay		Daphne		Shannon		Laura	
1	p	SA	5	D	2	A	4	A	4	U	3
4	p	SA	5	D	2	A	4	SA	5	SA	5
7	p	D	2	D	2	A	4	SA	5	A	4
9	p	A	4	A	4	A	4	SA	5	A	4
10	n	D	4	A	2	D	4	U	3	A	2
11	p	SA	5	D	2	A	4	U	3	U	3
13	n	D	4	A	2	D	4	D	4	SD	5
14	p	?	0	D	2	A	4	A	4	A	4
15	p	SA	5	D	2	U	3	A	4	A	4
16	p	A	4	D	2	A	4	A	4	A	4
20	n	D	4	A	2	U	3	SD	5	SD	5
25	n	D	4	U	3	SD	5	A	2	U	3
60 possible			46		27		47		48		46

Scoring

	SA	A	UN	D	SD
p = +	5	4	3	2	1
n = -	1	2	3	4	5

	T1	T2	T3	T4	T5
Personal	53	53	28	49	62
Outcome	46	27	47	48	46
TOTAL (125)	99	80	75	97	108

Personal Scores:
13-30 = Low efficacy
31-48 = Average
49-65 = High

Outcome Scores:
12-28 = Low expectancy
29-44 = Average
45-60 = High

STEBI - Post-Assessment 10/03/03

Personal Science Teaching Efficacy Belief Scale

Question		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	A	4	SA	5	A	4	SA	5	A	4
3	n	SD	5	D	4	A	2	SD	5	SD	5
5	p	A	4	SA	5	A	4	A	4	A	4
6	n	A	2	D	4	U	3	D	4	SD	5
8	n	D	4	D	4	A	2	SD	5	SD	5
12	p	A	4	A	4	U	3	A	4	SA	5
17	n	D	4	D	4	A	2	D	4	SD	5
18	p	A	4	A	4	A	4	SA	5	SA	5
19	n	D	4	D	4	A	2	D	4	SD	5
21	n	D	4	D	4	D	4	SD	5	D	4
22	n	D	4	D	4	U	3	SD	5	SD	5
23	p	SA	5	A	4	A	4	SA	5	SA	5
24	n	D	4	D	4	D	4	SD	5	SD	5
65 possible			52		54		41		60		62

Outcome Expectancy

Question		Marie		Tee Jay		Daphne		Shannon		Laura	
1	p	SA	5	D	2	A	4	A	4	U	3
4	p	A	4	D	2	A	4	A	4	A	4
7	p	D	2	D	2	D	2	A	4	U	3
9	p	UN	3	D	2	A	4	A	4	U	3
10	n	A	2	A	2	A	2	A	2	A	2
11	p	A	4	D	2	U	3	A	4	U	3
13	n	D	4	A	2	D	4	D	4	SA	1
14	p	A	4	A	4	A	4	A	4	A	4
15	p	D	2	D	2	A	4	A	4	U	3
16	p	A	4	D	2	A	4	A	4	A	4
20	n	A	2	D	4	D	4	D	4	D	4
25	n	D	4	A	2	D	4	D	4	U	3
60 possible			40		28		43		46		37

Scoring

	SA	A	UN	D	SD
p = +	5	4	3	2	1
n = -	1	2	3	4	5

	T1	T2	T3	T4	T5
Personal	52	54	41	60	62
Outcome	40	28	43	46	37
TOTAL (125)	92	82	84	106	99

Appendix H - Modified Nature of Scientific Knowledge Scale (MNSKS)

MNSKS Scoring instructions

Subscale	Item	Key
Creative		
	8	p
	24	p
	34	p
	38	p
	1	n
	4	n
	14	n
	19	n
Developmental		
	7	p
	22	p
	28	p
	30	p
	15	n
	17	n
	23	n
	31	n
Testable		
	13	p
	26	p
	29	p
	36	p
	5	n
	6	n
	10	n
	18	n
Unified		
	2	p
	16	p
	37	p
	39	p
	11	n
	21	n
	25	n
	32	n

For the four subscale scores:
8-23 = Unaccepted view
24 = Neutral view
25-40 = Accepted view

For the Total scale:
32-95 = Unaccepted view
96 = Neutral view
97-160 = Accepted view

Scoring

	SA	A	N	D	SD
p = +	5	4	3	2	1
n = -	1	2	3	4	5
Participant Responses	A	B	C	D	E

Scales and scoring procedure approved by Meichtry

Appendix H.2 - MNSKS: Participant Analysis

Modified Nature of Scientific Knowledge Scale - Pre Assessment 4/17/03

Creative		Marie		Tee Jay		Daphne		Shannon		Laura	
8	p	C	3	D	2	B	4	A	5	D	2
24	p	C	3	D	2	B	4	A	5	A	5
34	p	C	3	D	2	B	4	A	5	B	4
38	p	D	2	D	2	B	4	A	5	D	2
1	n	E	5	D	4	D	4	E	5	E	5
4	n	B	2	B	2	B	2	B	2	B	2
14	n	D	4	B	2	D	4	E	5	D	4
19	n	D	4	B	2	B	2	C	3	D	4
SUM			26		18		28		35		28
Developmental		Marie		Tee Jay		Daphne		Shannon		Laura	
7	p	D	2	B	4	D	2	B	4	B	4
22	p	D	2	B	4	B	4	B	4	A	5
28	p	B	4	B	4	B	4	A	5	A	5
30	p	B	4	B	4	D	2	A	5	E	1
15	n	D	4	D	4	C	3	E	5	E	5
17	n	D	4	D	4	D	4	E	5	E	5
23	n	D	4	D	4	D	4	C	3	D	4
31	n	D	4	D	4	D	4	E	5	E	5
SUM			28		32		27		36		34
Testable		Marie		Tee Jay		Daphne		Shannon		Laura	
13	p	D	2	B	4	B	4	D	2	B	4
26	p	B	4	D	2	B	4	A	5	A	5
29	p	B	4	D	2	B	4	A	5	A	5
36	p	D	2	D	2	B	4	A	5	B	4
5	n	C	3	D	4	B	2	B	2	E	5
6	n	B	2	C	3	D	4	B	2	B	2
10	n	C	3	D	4	D	4	E	5	D	4
18	n	C	3	B	2	D	4	E	5	D	4
SUM			23		23		30		31		33
Unified		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	A	5	B	4	B	4	A	5	A	5
16	p	C	3	B	4	B	4	E	1	B	4
37	p	D	2	B	4	B	4	A	5	B	4
39	p	A	5	B	4	B	4	A	5	B	4
11	n	D	4	D	4	D	4	E	5	D	4
21	n	D	4	D	4	C	3	E	5	D	4
25	n	D	4	D	4	D	4	E	5	D	4
32	n	D	4	D	4	D	4	E	5	E	5
SUM			31		32		31		36		34
Overall score	32-160		108		105		116		138		129

	T1	T2	T3	T4	T5
Creative	26	18	28	35	28
Developmental	28	32	27	36	34
Testable	23	23	30	31	33
Unified	31	32	31	36	34

Subscale scores greater than 24 and Total scores greater than 96 are toward the direction of the accepted view of NOS.

TOTAL 32-160		108	105	116	138	129

Modified Nature of Scientific Knowledge Scale - Post Assessment 10/03/03

Creative		Marie		Tee Jay		Daphne		Shannon		Laura	
8	p	B	4	B	4	B	4	B	4	B	4
24	p	B	4	B	4	B	4	A	5	B	4
34	p	D	2	B	4	B	4	A	4	B	4
38	p	B	4	B	4	B	4	A	4	B	4
1	n	D	4	D	4	D	4	E	5	E	5
4	n	C	3	B	2	D	4	B	2	D	4
14	n	D	4	D	4	D	4	D	4	E	5
19	n	D	4	B	2	D	4	A	1	D	4
SUM			29		28		32		29		34
Developmental		Marie		Tee Jay		Daphne		Shannon		Laura	
7	p	C	3	B	4	B	4	B	4	B	4
22	p	D	2	B	4	B	4	A	5	A	5
28	p	B	4	B	4	A	5	A	5	A	5
30	p	C	3	B	4	B	4	A	5	D	2
15	n	D	4	D	4	B	2	D	4	E	5
17	n	B	2	D	4	D	4	D	4	E	5
23	n	D	4	C	3	B	2	A	1	B	2
31	n	D	4	D	4	D	4	D	4	E	5
SUM			26		31		29		32		33
Testable		Marie		Tee Jay		Daphne		Shannon		Laura	
13	p	D	2	B	4	A	5	D	2	B	4
26	p	C	3	B	4	B	4	A	5	B	4
29	p	B	4	B	4	B	4	A	5	A	5
36	p	D	2	B	4	B	4	A	5	A	5
5	n	C	3	D	4	B	2	D	4	E	5
6	n	C	3	C	3	C	3	B	2	E	5
10	n	B	2	D	4	D	4	D	4	D	4
18	n	C	3	D	4	A	1	D	4	D	4
SUM			22		31		27		31		36
Unified		Marie		Tee Jay		Daphne		Shannon		Laura	
2	p	B	4	B	4	B	4	A	5	A	5
16	p	C	3	B	4	D	2	A	5	A	5
37	p	D	2	B	4	B	4	A	5	A	5
39	p	B	4	B	4	B	4	A	5	A	5
11	n	D	4	D	4	D	4	D	4	E	5
21	n	D	4	D	4	D	4	D	4	D	4
25	n	D	4	D	4	D	4	D	4	E	5
32	n	D	4	D	4	D	4	D	4	E	5
SUM			29		32		30		36		39
Overall score			106		122		118		128		142

	T1	T2	T3	T4	T5
Creative	29	28	32	29	34
Developmental	26	31	29	32	33

Testable	22	31	27	31	36
Unified	29	32	30	36	39
TOTAL	106	122	118	128	142

Appendix I - Mentoring Efficacy Questionnaire

Appendix I.1 - Mentoring Efficacy Questionnaire: Instrument

Please indicate the degree to which you agree or disagree with each statement by circling the appropriate letters to the right of each statement.
SA=Strongly Agree; A=Agree; UN=Uncertain; D=Disagree; SD=Strongly Disagree

1. I know what is expected of me as a mentor.	SD	D	UN	A	SA
2. I know about the induction process for new teachers.	SD	D	UN	A	SA
3. I know about the needs of novice teachers.	SD	D	UN	A	SA
4. I know about the needs of educators and students in urban settings.	SD	D	UN	A	SA
5. I model "best practices" and culturally relevant teaching strategies when instructing my students.	SD	D	UN	A	SA
For # 6-20 Each statement begins: I feel confident…					
6. conducting observations (collecting adequate, accurate observation data) and sharing the information with a protégé.	SD	D	UN	A	SA
7. coaching a protégé to become a more reflective, skilled, instructional problem-solver and decision maker.	SD	D	UN	A	SA
8. coaching a protégé to become a more effective instructor through diagnosis of needs, meaningful feedback, and collaborative goal setting.	SD	D	UN	A	SA
9. helping a protégé acquire effective planning, teaching and assessment strategies for student learning (collective and individual) in urban settings.	SD	D	UN	A	SA
10. assisting a protégé in developing a professional development plan for future growth.	SD	D	UN	A	SA
11. using the INTASC standards and TN's Framework for Evaluation and Professional Growth as a means to assess the quality of a protégé's teaching.	SD	D	UN	A	SA
12. providing nonjudgmental listening and emotional support for a protégé.	SD	D	UN	A	SA
13. balancing my own work and life responsibilities with mentoring a protégé.	SD	D	UN	A	SA
14. socializing a protégé into the culture of the school and district.	SD	D	UN	A	SA
15. orienting a protégé to the internal and external expectations of teaching professionals.	SD	D	UN	A	SA
16. introducing a protégé to important contacts such as members of the community.	SD	D	UN	A	SA
17. helping a protégé acquire necessary resources.	SD	D	UN	A	SA
18. with my role as a change agent.	SD	D	UN	A	SA
19. using knowledge of high-performing schools and learning communities to facilitate the professional growth of my colleagues.	SD	D	UN	A	SA
20. helping a protégé implement inquiry-based science instruction.	SD	D	UN	A	SA

21. What do you feel are your greatest strengths as a (potential) science mentor?
22. What do you feel are your greatest challenges as a (potential) science mentor?

Appendix I.2 - Mentoring Efficacy Questionnaire: Participant Analysis

Mentoring Efficacy Questionnaire - Pre 4/17/03

	Marie		Tee Jay		Daphne			Shannon		Laura	
1	A	4	A	4	UN	3		UN	3	UN	3
2	A	4	A	4	UN	3		A	4	D	2
3	A	4	A	4	UN	3		D	2	SA	5
4	A	4	A	4	A	4		A	4	A	4
5	A	4	A	4	A	4		A	4	UN	3
6	A	4	D	2	A	4		D	2	A	4
7	A	4	UN	3	UN	3		A	4	A	4
8	A	4	A	4	A	4		D	2	UN	3
9	A	4	A	4	A	4		D	2	UN	3
10	A	4	A	4	A	4		D	2	UN	3
11	A	4	UN	3	UN	3		D	2	UN	3
12	SA	5	A	4	A	4		A	4	A	4
13	A	4	A	4	A	4		UN	3	UN	3
14	A	4	A	4	A	4		A	4	UN	3
15	A	4	A	4	A	4		D	2	UN	3
16	A	4	A	4	UN	3		SD	1	UN	3
17	SA	5	A	4	A	4		D	2	A	4
18	UN	3	A	4	A	4		A	4	UN	3
19	SA	5	UN	3	UN	3		SD	1	UN	3
20	A	4	UN	3	SD	1		A	4	UN	3
Sum		82		74		70			56		66
	T1	T2	T3	T4	T5	**Scoring**					
Pre	82	74	70	56	66	**SA**	**A**		**N**	**D**	**SD**
Post	80	78	75	69	75	**5**	**4**		**3**	**2**	**1**

Scores:
20-40 = Low mentoring efficacy
41-60 = Low intermediate mentoring efficacy
61-80 = High intermediate mentoring efficacy
81-100 = High mentoring efficacy

Mentoring Efficacy Questionnaire - POST 10/03

	Marie		Tee Jay		Daphne		Shannon		Laura	
1	SA	5	SA	5	A	4	A	4	UN	3
2	A	4	A	4	A	4	A	4	UN	3
3	A	4	A	4	A	4	A	4	SA	5
4	A	4	SA	5	A	4	A	4	SA	5
5	A	4	A	4	U	3	A	4	A	4
6	SA	5	D	2	A	4	U	3	A	4
7	A	4	A	4	A	4	A	4	A	4
8	A	4	A	4	A	4	U	3	A	4
9	A	4	A	4	A	4	U	3	A	4
10	A	4	A	4	A	4	A	4	A	4
11	A	4	D	2	A	4	U	3	A	4
12	A	4	A	4	A	4	A	4	A	4
13	A	4	A	4	U	3	D	2	A	4
14	A	4	A	4	A	4	A	4	UN	3
15	A	4	A	4	A	4	A	4	UN	3
16	A	4	A	4	U	3	D	2	UN	3
17	A	4	A	4	U	3	A	4	A	4
18	UN	3	A	4	U	3	U	3	UN	3
19	A	4	A	4	A	4	D	2	UN	3
20	UN	3	A	4	A	4	A	4	A	4
Sum		80		78		75		69		75

Appendix J - Pre and Post STAM Records of Activities

T = Teacher
T? = Teacher question
S = student
S? = student question
Ss = students
S-S = student to student interaction

Appendix J.1 - STAM Record of Activities Pre-Observations Marie

Date	Tape	A or T	Start Time	Description	STAM Code
3/7/03	1	T1	0:00	Ss enter, stand, and wait to be seated. T places s envelopes on tables and then requests for ss to be seated. T passes out cards to ss who are sitting quietly and waiting to begin. Ss say, "Thank you."	
	1	A1	0:02	Review of last week's lesson. T - Good Morning class. Ss - Good morning Mrs. Venable. T - Who remembers what we talked about last week? S - We talked about the planets. T calls on s using the Go-Around cup. The s doesn't remember. T pulls another stick. S - We talked about the earth's rotation and how it goes around the sun.	13A 14A
	1	T2	0:04	T - So we sort of finished up with the solar system last week and this week we are going to move on to a new area chemistry. We will talk about matter - solids, liquids, and gas. But first I want you to listen to something.	
	1	A2	0:05	Introduction to Chemistry and Matter T begins a tape recording of Chemistry professions - children on tape singing and describing professions in chemistry. T and ss sit quietly and listen.	1B 2C 3C
	1		0:08	Tape finishes and T discusses the tape with them. T- What did the tape say about chemistry? Ss - It's the perfect job, and it can help people; one s's grandmother mixes medicine. T - How many of you like to bake things? Many raise hands - When you mix things together you all can be chemists right in your own kitchen.	4A 7C 8C 13A 14A 15C
	1		0:09	T has words Matter, solid, liquid, and gas written on display cards. Let's learn about some things that have to do with chemistry. Matter is anything that takes up space - so are you made of matter - yes. One s playing and he has to turn in a card. Now touch your finger to your tongue, in science we call that saliva, can you say saliva (not spit). Saliva is also and points to matter and ss say matter. Matter can come in three different forms and ss read them with her - solid, liquid, and gas. One s asks about picking jobs - T says they will pick them before they go to the computer. Solid is something that is a definite shape - T gives lots of examples. Liquid is something like you would pour - ss say like water, milk, or lemonade T - What is gas - gas can be the air that we breathe. Ss - gas for cars. T says ok let's talk about the gas that you put in cars and let's not shout out. T describes gas that is poured into a car as a liquid and then describes exhaust as gas.	

				T- How many of you have bicycles? - the air in the tires is gas. How many of you like hot chocolate? - the fumes/steam/vapor is the gas. There are 3 forms of matter - holds card - solid, liquid, and what? all say gas.	
	1		0:14	T holds up cards with pictures of a solid, liquid, or gas (e.g. balloon filled with air) - asks one side of the room at a time to call out what it is. T pulled a s's name and asked him to tell her a name of a solid. - you need help? - He nods yes. One s says a rock. T - Why is it a solid? S - because it's hard. T - and it keeps it's own shape.	
	1		0:16	T - Look at the computer to see what we will do - T will choose side that gets to go to computers first based on their behavior. T tells them they can do the matching and practices with them. T- Bubbles solid, liquid, or gas - Most ss say gas but one says I thought it was a liquid- T says when you pour it it's a liquid and what you have blown out is a gas - you have to blow air. 2nd you can sequence the order of pictures. For practice, she calls on one side to determine what should be first, etc. Do not go on the music box.	
	1		0:20	Whole class practices identifying objects again - popsicle; ss guess liquid then solid. T says when it melts what does it become). (A visitor comes in and one side says be quiet so we can get to go to the computers first. The aide talks to the other side. When visitor leaves, T tells one side they were doing a great job.) T showed ss the quiz part of the software. Which of these is not matter? toys, laughter, - T says now anything with feelings is not matter, sadness, A couple of ss say happiness and anger. Two ss had to turn in card - had trouble participating.	
	1	A3	0:24	T gives out manager jobs for this 6 weeks. Managers (4)- end of class (lines up ss at end of class) - neatness (push chairs up); lesson (pass out supplies); absence (keep track of absent ss). T takes up folders and shuffles them behind her back and chooses the one on top to give them a job - one per side. Several ss lost cards for "calling out" during this time. Ss excited about being chosen for a job, "Yeah, I got a job." T- Remember to return your card when you leave the room. T congratulates them all. So next time you come in get your cards first.	13A 14A
	1	T3	0:30	T chooses blue side to go to computer first. Aide helps them get on the computer and helps them with programs they were assigned to. T works with green side.	
	1	A4a	0:31	T directs group of ss in making "gloop" activity. T hands out a plastic bag with a dry white powder inside (corn starch) to the ss. What you see in the bag is a what? Ss - a solid. It feels like flour. They look at it and talk with each other about it. T - We will put some water (colored green) in it and just enough so that it will be a solid and a liquid.	1A 2A 3A 4C 6B 8A

				SS - Can I stick my finger in it? Eat it? T- No you don't eat anything unless I tell you. She pours liquid in bag for ss and closes the bag. Liquid is green (s asks about it and T says it's food coloring). Once liquid is poured ss are asked to mix it. Part of it should run like a liquid and the other part should be solid. S - I can't push this - it's hard. T demonstrates holding it upside down and letting it ooze. Ss open the bag and smell it on own. Ss keep playing with their bags. One boy says it's "alien blood." "Work it, work it, work it." Ss look at and play with each others bags. A s asks what was in the bag. T - What do you think? One says corn meal. T says - what color is corn meal? Other s says flour.	13B 14B
	1	T4	0:45	T tapes bag so they can't open them and gives them marker to put their name on it. Ss who completed activity are asked to work on the computers while the ss on computer return to table for activity. (Blue section distracted by camera.)	
	1	A4b	0:51	T works with group that had been on computer (blue) - same activity as she completed with the green group. S - What's that white stuff? T - That's what you're to guess. S - Is it soil? T says soil? One s that can see in the box says corn starch. T gives them a paper bag to place the plastic bag in so they can take it with them.	
	1	T5	1:01	Green group returns to table from computer and whole group sits together.	
	1	A5	1:02	Closure T - All of you did a good job of making the gloop. Take it home and look at it with your parents. It should be a solid and a what? Ss say - Liquid. T - Is the gas the air in the bag? Most quiet and a couple say yes (they are playing with bags). What do you think was in the bag? S - corn starch. T - Why? S - I could see in the box. T - So what are the three states of matter. Ss respond solid, liquid, and gas.	1A 7C 8A 10B 11C 13A 14A
	1	T6	1:04	Calls for end of class manager and other managers to return cards. End of class managers call their classes and ss return folders to T as they line up. Absence manager writes if ss were absent on back of folders.	
	1		1:07	End of Tape. Class ends and ss leave.	
3/13/03	2	T1	0:00	Ss enter class and are being seated on green or blue side in place next to folder. T passes out cards to those who are sitting and waiting. Told managers they should have gotten their tags when they came in. Asked green side to get theirs first. One s called out and had to bring T a card. T helps one s put her manager tag on her shirt.	
	2	A1	0:03	Review of last week's lesson.	1A

				Pulled stick from Go Around Cup for s to answer. The s could not answer and she chose another stick. Can you tell us what matter is? S - He said solid, liquid, or gas. T said those are the kinds of matter. Something that's made of... T- are feelings matter? Ss -No. T - We did an experiment and what did we do? S - We made the green stuff. T - What did it do? S - It got hard. T - Describe it. S -Some was soft and some was hard. T - So some was a --? Ss say liquid and some was a ----? and ss say solid. T -What was the gas in that? S - the bag; T - what inside the bag? S -the air. T - What did we do on the computer? S - matching. T - did we do the part where you had to read? S - No. T - Maybe we can do that part today.	7C 8B 10B 11C 13A 14A
	2	T2	0:06	T complimented ss on their performance during the review. T asks class managers to pass out index cards (pink and green) on sticks to each s. Pink says solid on one side and liquid on the other. Green says gas. T asks ss to set cards down on the table.	
	2	A2	0:09	T asks ss to hold up the corresponding card when she shows a picture of a solid, liquid or gas. They practice spelling solid and liquid first. T asks the ss to hold up their cards instead of saying the words during the practice. Examples of cards shown: Glue, leather shoe, gas pumped into car (T - listen to why it's a liquid - one person had it right - T asks s to explain why - when does it become a gas. S - when it comes out the tailpipe), diamond, hair (one s wanted to know why it was a solid instead of a liquid - T explained and described wet and dry hair - it's in a solid state naturally), carbon monoxide (This is what one s told us comes out of that car), air bubbles (one s had to turn in a card for calling out). T says 100% very good when all ss get the correct answer. T - Now the three forms of matter are: ss say together solids, liquids, and gas.	
	2	T3	0:16	T chooses one side (blue) to go to the computer and the other side to work with her on an activity. T - On the computer you can do any of the activities but you must read first. Aide reads one of the reading activities to class - With 3 quiz questions at the end.	
	2	A3a	0:20	Play-Dough activity T asked green side manager to pick up cards and asked the group to gather around the middle table for activity. T - Don't touch the materials, if you touch you sit (one girl was asked to take 5 - then a boy). T gave each s a handout with instructions and ingredients for making play-dough. S - Ooh how to make play-dough, cool! T - Let's read over it first. What is flour - a solid, liquid, or gas? Aide put the ingredients in a bowl and mixed it for them. Aide asked one s to pour a little water in the bowl. One s compared this activity to making gack in PrimeTime. T- You were mixing solids and liquids. (0:28 Two time out	1A 2C 3B 6B 8A 13A 14B

				ss return.) T - What did it turn out to be? Ss say a solid.	
	2		0:29	Each s given a piece of the play dough T asks them to return to their seat and make a smiley face with it. T told them they can make this at home because they have the recipe. One s made a snake. T asked them to make smiley faces. T - When you go back to your room - where are you going to put this? S - In your backpack. Another s - what if you don't have a backpack? T - You should have some place to put it. Put it in the refrigerator so it won't mildew/mold. Ss given baggie to put play-dough in.	
	2	T4	0:34	Green ss go to computer and blue ss return to table. T asks blue to come to table and not to touch. Aide is going to be our chemist and mix it all together.	
	2	A3b	0:35	Blue side completes the same activity of making play-dough.	
	2		0:38	T circulates to computer while Aide continues with activity.. S - can we do the jukebox? T- not today; do the activities I told you about. T returns to activity w/assistant. (0:39) Aide - let's use green and red and make orange. T says OK. S helps to pour water in. Ss - Ooh it's going to be rainbow; no it's going to be brown; green. S - Can we put more color in there? Aide - no. S - There's not even a name for that color. Other s - it's a dark green. Aide - this is like an olive kind of green - you kind of learn something about mixing colors too. S - I love olives. (All ss working on computers w/out any assistance - some two/computer)	
	2		0:46	T asks ss to roll the play-dough some and then to make a smiley face. T- so what did all of that come out to be - a solid, liquid, or gas. All say solid.	
	2	T5	0:50	Green group asked to return from computer. All ss asked to keep play dough in bag. T gives all ss cards who have their play dough put away and have participated well.	
	2	A4	0:52	Closure T asks ss which ingredients were solid, liquids, or gases. She used the Go Around Cup to call ss. T - Name one solid on your paper. S - salt. T - good. T tells one s he can earn his card back if he can tell her a liquid. S -water. T - name me a gas - S - Air. T - Name a solid. S - Liquid? T - solid; you can say what's in your hand. S - play dough. T - Play-dough is a what? Say it. S - solid. T - Is flour a solid or a liquid? - a solid even though you can pour it.	1A 7C 8A 10B 11C 13A 14A
	2	T6	0:56	T asks managers to return manager cards and asks them to call classes to leave. If you have 10 cards you can stay behind and get a prize. Ss choose 2 prizes from bag. (eraser and a toy)	
	2		1:01	End of Tape. Class ends and last ss leave.	
3/21/03	3	T1	0:00	Ss enter and sit on green or blue side next to their folders. There is no Aide today. Another teacher came in with a guitar in order to play and sing a song about matter with the ss. They sing,	

				What is Matter? to the tune of 3 blind mice. Ss go to get manager cards.	
	3	A1	0:03	Ss sing What is Matter? T - We have a song to go along with what we have been learning about matter. Ss and T read it together. *What is matter? What is Matter? A solid, liquid, or gas. A solid, liquid, or gas. It takes up space and it weighs something too. It's everywhere* -- *that includes me and you. Did you ever think such a thing could be true? That is matter. That is matter.* (Tune of 3 blind mice). Sing all together and then as a round several times. All ss participate.	1A 13A 14A
	3	T2	0:14	T asks ss to give the visiting teacher a big hand (And firecrackers). T -From the song we can see that everything is matter except feelings. Some ss say imagination, anger, etc.	
	3	A2	0:15	Review of last week's activity. T - Remember the experiment we did last time. What did we do? Ss - we made play-dough. One s tells the ingredients - water, salt, vegetable oil, green food coloring. T - Wasn't that good - she did a good job remembering all of that. One s said flour too. T - that's right. We are going to do something different today and we'll compare the play dough to what we do today.	1A 7C 8A 10B 11C 13A 14A
	3	T3	0:18	T asks managers to pass out solid/liquid/gas cards on sticks. T - What are you supposed to do with the cards when you get them? Ss lay them down. T- did I say use them as a fan? Ss - no. T - let's see how many are being obedient.	
	3	A3	0:20	T holds up picture cards and asks ss to hold up the solid, liquid, or gas stick that corresponds to the picture. T - These are response cards - that means they respond for you and you don't use your what? Ss say mouth. T shows picture but does not read it to them this time. Hair (100 % solid), shoes, etc. T - You are doing such a good job at using your response cards. Steam (all but one hold up the gas card - he held up solid because he thought it was the train), gasoline (all had liquid).	1A 2C 3A 4A 6B 7B 8A 10B
	3		0:26	T demonstration of pouring liquid into containers. T - What does it take the shape of? S - the glass. T- The liquid takes the shape of the container. Air into a balloon takes the shape of the balloon too (air as a gas).	11C 13A 14A
	3	T4	0:29	T sends green side to the computer and helps them get started.	
	3	A4a	0:32	Silly Putty Activity - Blue side gathers around table. T - This is what we are going to do. We are going to see what happens when we mix two liquids together to make something else. T - Holds up poster that says Silly Putty. Objective: To show ss what happens when two liquids are mixes together to form a solid. (This and title is not read). T reads Materials: Glue, cups, popsicle sticks, borax solution, food coloring, and plastic food bags. She describes what borax solution is. Also need goggles. She described disinfecting the goggles since other ss had been using them too. Let's put the glasses on first and be a little silly.	1B 2C 3C 4C 6B 8B 13B

				T gives each of them a cup (ss say thank you). One s fussing w/glasses. Another s says don't worry about the glasses, worry about the project. T pours glue in each of their cups. T - is glue a solid, liquid, or gas? Ss - liquid and try to guess what it's going to be. T - those of you not talking will receive the cards after this. T lets the ss on the computers know that she can hear them talking and tells them they should be using 6 inch voices. T - Gives each a popsicle stick and calls them stirs since they are chemists (plastic spoons=teaspoons). T allows ss to pour a teaspoon of water into cup. One s says he knows how to measure since he takes medicine. Make sure to use your stir instead of the spoon. T - I'm looking to see who will earn their card. T adds 3-4 drops of whatever color each s wants (yellow, green, red, blue). (0:40) T hears a s on the music box on the computer and asks this s to come take 5. (S comes w/out complaint). Ss are asked to stir and not stop. T asks them to mash all air bubbles out of substance. Gives them one glove (don't touch anything unless you are told to) and then they roll it to get all of the water/glue out. One s lost a card because he was getting impatient. S - Is we making a bouncy ball? T- it's sort of like that. It can bounce, and also you can pick up stuff from your paper.	14B
	3		0:45	Clean up. T asks ss to take their spoon, cup, and glove and put them in the trashcan. T - What are you going to do with it when you return to the room? Put it in the backpack.	
	3	T5	0:47	Computer group and activity group trade sides. T assigns ss one at a time to the computers and asks them to do the reading first.	
	3	A4b	0:48	T asks ss from green table to come over one at a time to start activity. They complete the same silly putty activity as the blue group completed. (I checked in on the computer group. One girl was having trouble reading and I helped her do the reading section on the computer.) T - Why do you have to wear goggles when we do stuff like this? S - it can explode. T - It could get in your eyes and we don't want that.	
	3		0:57	Gave ss a baggy for the silly putty and asked them to throw away the rest of their materials. (0:59) - one s using sink and she asked him to return to his seat - "did I tell anyone to use the sink?" Green group has returned to seat.	
	3	T6	1:00	Both groups return to whole group for closure. T - gave ss cards for returning from computers nicely and for participating well.	
	3	A5	1:02	Closure - T uses go around cup to call on ss. T -what was the difference between the Silly Putty and the Play Dough? Ss - One's bouncy and one's not; you put glue in this one. T- Is glue a solid or a liquid. All ss say liquid. T- What did I put in the other one? S - flour.	1B 7C 8C 10B 11C

				T- Who can tell me one liquid we put in the silly putty. Ss - water; food coloring. One s said gases in the air. T - We put a borax solution - and we mixed all of these things and now you have a rubbery what? Ss say solid.	13A 14A
	3	T7	1:05	End of class managers are asked to call their groups. Some are talking about how it's bouncy. T - Do you think the glue is making it bouncy? Some say yes. One s said mine broke. T tells two ss who didn't get to make some that they could after everyone had left since they had been quiet. Those who had earned prizes got them.	
	3		1:07	End of Tape. Class ends and ss leave.	
OVERALL COMBINED LESSON CODES					5C 9C 12A 15A 16C 17C/D 18C/D 19B 20A 21B 22A

Room posters etc. - Matter poster (solids, liquids, and gases) & poster of mixing and baking (for chemistry) human body posters - numerous (of systems); mosquitoes and volcano chart; posters of animals, etc.; class managers chart, word chart; 6 computers, States of Matter; many living organisms (fish, bees, guinea pig, lizard).
T uses Go-Around Cup (has sticks with each s's name) to call on individual ss to respond to questions.

Appendix J.2 - STAM Record of Activities Post-Observations Marie

Date	Tape	A or T	Start Time	Description	STAM Code
1/7/04	1	T1	0:00	As ss were coming to class they were called to the gym for a 2nd grade assembly. T asked if they could come to class instead and attend the assembly later. This was agreed upon but they came to class about 15 minutes later than normal. 1st day back to lab after Christmas break. Ss enter classroom, sit in assigned sections. T gives each s a card if they sit as they should. T allowed each s to share some things they had done over Christmas break - We made water bottles; had a good time; camping; flu shot; etc.	
	1	A1	0:03	T describes that they will be working with plants over the next month. T reviews what ss had studied earlier in the school year. Uses a transparency called "Inside a Seed" with a sketch of a seed which has names of parts listed at the bottom (food storage, seed coat, little plant/embryo) and ss are asked to name the part when T points to the corresponding part of the picture. Ss remember the parts well - call out answers.	1B 3C 7C 8C 10B

				T uses second transparency with the words - "Plants need soil, water, light, and space to grow." T - What do plants need to grow? Ss read the transparency to her	11C
	1		0:05	T lets them know that they will work in groups. She uses a transparency with the roles that will be assigned in each group. T asks ss to read a description of each role from the transparency with her. Supplier - gets the materials and supplies for the group. Reporter - reports to the class for the group. Recorder - writes down what the group does (T tells ss they will be given a sheet to record the information) Encourager/Timekeeper - Someone to be like a cheerleader and keep the group on task. T- so that's 4 things. You will be a ... T points to each word and asks ss to say the words with her.	
	1	A2	0:07	T lets the ss know that they will be working with Fast Plants. She reads a story about Fast Plants (*include book reference*). As she reads she asks them, How many of you like to eat cereal? cornbread? (many raise hands). "..Imagine his surprise when he saw tall Brassica plants." T - asks ss to say Brassica. They do. T continues reading. After the honeybee went from flower and more and more plants came up it produced more what? Ss - nectar. T - Nectar right, but what else came from the plants? Ss- seeds. T - so when he harvested the plants he saved the seed for the next year. Why do you think he saved them? S - so he could eat them. T - Right so that he could plant them and have a new crop of plants. T - So years later a plant explorer found these same plants. What do you think he did with them? Many ss try to respond. T - I like your hand over there and calls on the girl. S - He took the seeds to his lab and studied them. T - that's exactly what he did. A researcher from the University of Wisconsin, say Wisconsin. Ss- Wisconsin; one s talks a little about Wisconsin. T - you know where Wisconsin is to s? T continues story - this scientist continued to grow and study Brassica plants like broccoli, turnips, and greens. How many of you like broccoli? Ss - ooh! (negative). 0:13 We are going to do a research plot. I want to keep this question in mind. How many seeds do you think we can get from 1, 2, or 3 seeds? S- 5. T - Keep it in your mind. T- Where do seeds come from? Ss - a plant. T - What can seeds become? Ss- a flower. T - What's inside a seed? Ss - nectar, embryo. (One student generally calls out response first and others follow with same response.) T - What we just looked at, an embryo. What does a seed need in order to grow? Ss- call out responses. T - I like your hand and calls on boy. S- Sun, space, water, and light. T - Very good. Are all seeds alive? Ss- Yes. T - Is each seed different? Ss- Yes. T - Are you all different? Ss - yes so seeds are different seeds and sizes as well.	1C 2C 3C 4C 7C 8C 10B 11C 13B 15C
	1		0:14	T - So we are going to look at Wisconsin Fast Plants. T holds up a poster with materials that	

				they will be using: Wisconsin Fast plants, quads, potting mix, diamond wicks, water mats, fertilizer pellets, plant labels, dried honeybees, pipette, algae squares, water reservoir, Wooden stakes; plastic support rings. One group might not get to plant today; but I will come get your group so that you can plant them later. T carries seeds to each group to let them look at them. S - Can we actually go first? T - I'm watching to see. T calls out each item that they will be using and holds up the object for ss to see (from materials poster). As T describes wicks she compares them to the wicks that she used in kerosene lanterns when she was growing up. T describes that the honeybees were bought and they weren't from the batch of bees that they have in the classroom. T - What do you think the bees are for? I want someone from the blue side. Hands please. S - They will help the plant. T - In what way? S - to make seeds. T - It helps to pollinate to make seeds. S - I have a question. Are those bees alive? T - No they aren't alive. T describes algae squares and compares the use of them to the need to control algae in a fishtank. Girl student complains that several are messing with her. T - "And I see you turning around too." If you turn around again I will take one card. S - Described using magnets to clean algae from a fish tank.	
	1	T2	0:20	T sends one group (green - 4 boys and 4 girls) to computers to work (with T assistant) on a plant program and T keeps the blue group to look at seeds and plant. T gives each student a card for appropriate class participation if earned. 2-3 ss were skipped. Ss are asked to gather around a display table with teacher. T arranges ss around display table as they were seated at their original table and assigns them into two groups.	
	1	A3	0:23	T gives ss one minute to self-select their role (reporter, recorder, supplier, encourager/ timekeeper) within each group. They attach a clothespin label of their role to their clothing. Group 1 - 2 girls/2 boys; Group 2 - 2 girls/1 boy. Girl in group 2 - I think we all would be good encouragers. 0:25 Timer goes off. T lets ss know that they will look at seeds using microscopes (hand-held and standard size). T shows ss how to turn on the hand-help scopes. T shows each group the recording sheet. Need to include their names, date, a sketch, complete a sentence that says I think the ______ is _______; and fill in a box of their guess as to how many seeds they think one seed will produce. T gives materials to supplier and the recording sheet to the recorder of each group. T asks the two groups to spread out to do their observations.	1C 3C 4C 6B 7C 13C 14C 15C
	1		0:28	T takes seeds and white piece of paper to ss.	
	1	T3	0:29	Announcement on intercom. "Ts Code Red" T- Oh no, that means I've got to lock the door. S - why, what's that mean? S- Because that's a drill if strangers are in the school. S - that one that we are practicing in case someone breaks in? Ts - gather ss in center of room on floor; close blinds and turn off lights. 0:32 - Announcement - "Ts and staff Code Green"	

	1	A3 cont.	0: 33	Ss move immediately back to computers or their seeds. S observations: the seed has dots on it; sunflower seeds are alot bigger Some students use the microscopes to look at the seeds. 0:38 I'm going to give you two minutes and then we need to move on. S - did you see how many circles were on there? S - maybe 15. 0:39 Now I need the reporter to show their sheets. Ss scramble to finish writing.	
	1		0:42	Reporter from one group - "the plant is great". T - and how many seeds/plants do you think you will get from that seed? S - 5. The second group wrote, the seed is dotted and guessed there would be 18 seeds produced. T - now share your pictures. Good. 0:43 Ok we only have 5 minutes to plant so we need to get started. Group transitions to round table next to aquarium. T asks suppliers from each group to fill the reservoir with water and place the water mat on top of the tub. T helps ss remaining at table label partner names on the quad. T asks suppliers to place an algae square in the reservoir. T asks ss to fill the containers half full with potting soil and to put two fertilizer pellets in. 0:51 Classroom teacher comes to pick up class - she takes the group from the computer to her class and T says she will take the rest of the group when they finish planting. 0:54 As ss finish with fertilizer they fill up the remaining part of the container with soil and place 3-4 seeds in each cell block. S - How do I put the seeds in? T - remember the farmer from the story just threw his out there and they grew so it doesn't matter. 0:59 T demonstrates use of pipette and asks them to water their plants. Some ss have difficulty using the pipette; other ss try to help them.	
	1		1:02	End of tape - T returns the 7 ss to their regular classroom.	
1/14/04	2	T1	0:00	Ss enter room and sit as T passes out their nametags and cards if they have entered quietly. T sets up overhead projector.	
	2	A1	0:02	T shares a transparency about different parts of the developing Fast Plants - growth tip, etc. T - Who remembers what we did last week? S- we read the story about Fast Plants. T uses Go-Around Cup; T - Richard tell me the name of the little thing that we put the plants in. S- you mean the little white thing. I don't know. T - can you help him out Sabrina? S doesn't remember. T- Does any one remember the name? The cell, the cell block, Ok. T reads transparency to ss. OK, the seeds begin to germinate, say germinate. And that means that they start to grow. T - shows a transparency of a picture of the Fast Plants as they germinate. T - What do plants need in order to grow? (asks a student from cup) - Emmanuel - water, light, soil, and space. We are going to look at the stems, leaves, flowers, and growth tips today. We are at about day	1C 2C 3C 7C 8C 10B 11C 13B

				9 and it looks about like this (shows them on transparency). These seeds grow into plants and then make what? Ss- flowers. T - and these flowers produce what? Ss- seeds. T- we are going to remove plants from each cell if there is more than 1 plant in the cell. T - returns to transparency - We will see leaves and they have many pores called stomata. Say stomata. Just like our skin has pores. Take in CO2 and releases O2; Photosynthesis - producing food, carbohydrates or sugar. Can you say photosynthesis? Now you will learn more about that at another grade. But right now what do we know a plant needs in order for a plant to have photosynthesis? Ss- water, soil, sun, and space. T - what takes the place of the sun with our plant setup? Ss- the light bulb. T - that's called a grow light. Say grow light. And it has nutrients that we put in it. S - Can we put worms in it? T - no worms. Compliments ss who are behaving and threatens to remove cards from those who are not listening.	
	2	A2	0:11	T shows the class their recording sheet (same type as previous week) and reminds them to put the date and names on the paper. T - Use your creativity when you fill in the statement "The ____ is ______." T also reminds them of their roles (recorder, etc.). They also need to match some terms with definitions and glue them to the back of their papers. Let's try one together. How about root? Raise your hand if you hear the correct definition. It has a baby plant inside, the part of the plant that collects sunlight (about 6 raise hands); the underground part of the plant that absorbs water & minerals from the soil (most raise their hands). Each group has about 15 minutes to complete this activity. T - any questions? S - When they get alot bigger where are we going to put them? T - We can probably transplant them and some of you can take them home. But the main thing we are going to do is collect seeds from them. What do you think you can do with them if I give you some. Ss- plant them. S - Are we going to use the dried honeybees to move the pollen? T - It says on the schedule that you do that around day 13 so we'll have to wait. S- Can we sell our flowers? T - Why would you want to sell them? S - So we can get some money. T - Well that will be a choice that you will have to make. I'm not going to sell them here in the lab, because they are here for you to have fun and to learn. So that's what you should do, pass on your learning with others. So once you learn you can teach someone else. S - Can we plant some outside? T - Well, we'll have to think about that. Would you put them outside now? Ss- no. T - Why wouldn't you put them outside right now? Ss- It's too cold. T - when would be a good time to put them outside? Ss- Summer. T - because there's more sun and rain in the summer.	1B 3C 8D 10B 13B
	2	T2	0"16	Ok green side needs to go to computer first (takes a card from a couple of ss). TA is going to work with you to set up the computers.	
	2	A3a	0:17	T asks blue group (2 boys, 4 girls) to look at their plants. T - now look at the leaves, lets see if see something different about the leaves. S - yes, it looks like they have hair on it. S - you need	1B 3C

				to give it some space it needs to breathe. T - Now that one we'll probably have to stake it up. T uses tweezers and removes plants from the cell blocks that have more than one plant. Look. S- Ooh look at the roots. T places removed plants in a ziplock bag. S - put water in there. T - It will be Ok. T - It looks like if I take this one out the other will come out too. S - It's like a tree that grows in half. T - That's right. It's like surgery. Now look at this leaf, it's called the true leaf. S - What does that mean? T - It means it was the original leaf. S - It's beautiful. S - Hey look there's alot of them. T - and the new leaves are coming out of them. S- Have you ever found a four-leaf clover before? S - I have. S - One year I found four. T - Now let's see how you measure these. But you need to be very careful because the plants are very delicate. We are going to use centimeters. So how tall is this one? Ss- about 5. T - that's about 4 and a 1/2 isn't it? Ok now you will need to draw your cell and then decide how you will show your plant. S - I think they need a little more water. (Repeats) T - gives drawing sheet to each recorder and gives the matching materials to the supplier. You are going to have 10 minutes. I'm going to be the time keeper. (Sets timer) Ss sit at two different tables to work. Ss get a pencil and some glue if they need them (on own).	4C 6B 8C 13C 14C 15C
	2		0:25	One group (2 girls, 1 boy) Ss share the drawing responsibility and measuring responsibility. Group two (2 girls, 1 boy) ss are drawing a plant on the page and using a ruler to measure how tall the plant they drew was. I suggested that they measure the actual plant rather than their drawing. It was 1 1/2 inches. They did not know how to write 1/2 and I helped them out with that. 0:34 - 10 minute timer went off and teacher gave them 5 more minutes to finish. Group one working on puzzle. One student had matched them and a second student checked over them. Seed was matched to "a tiny leaf that comes out of a seed." S-s How can a seed be a tiny leaf that comes out of a seed? S - Don't ask me. There was a second seed label. T told them that the person that copied it must have put an extra one in the bag by accident and removed it for them. S- We need help with this definition - the tiny leaf that comes out of a seed. T - What do you think they are? S - leaves, flowers, no growth tip. T - right. S- The part of the plant where new leaves and flowers are found. T - I'm sorry we had it wrong. Where's the growth tip? You all need to help me now. (As teacher is working with group one, I'm helping out group 2.) T helps group one finish up their matching. S - can we look at the hamster? T - for one minute. That's all we have time for.	
	2	T3	0:41	T asks the ss to give her their recording sheets and line up to go on the computer. Ss on the computer return to their seats. T compliments them on their behavior working on the computers.	
	2	A3b	0:42	T asks ss to gather around the plants in their groups. Group 1 (3 boys/1 girl); Group 2 (2 girls/1 boy). Now the last group earned cards because they worked very well together. The first thing	

				that we have to do is to remove plants from cells if there is more that one growing in the cell. Why do I need to do that. S - to give the plants space. T asks a student to put the plants in a ziplock bag. T - I'm watching and listening to see who is listening. S- Are we throwing these away (referring to plants in the ziplock)? T - No. What do you think we should do with them? S - put them outside. S- put them in the garden or greenhouse. T - That's a good experiment we can put them in the greenhouse to see if they grow. S - Why do they call it the greenhouse? S - Because they have green stuff growing in it. T - That's right.	
	2		0:47	Now you all need to work as a team to complete your worksheet. You are going to measure how tall your plant is in centimeters and record your information on your sheet. Ok you have ten minutes to work. Group one works on the floor and shares the recording. T measured plants for this group to save them time. T - they are all about 1 cm. T draws four cell blocks on the paper and demonstrates how they can draw and label their plant in one cell. S (girl) - continues to fill in the other 3 blocks. 3 boys work on sorting the vocabulary while girl completes the sheet. T works with group two and helps them put vocabulary on the sheet.	
	2	T4	1:00	T asked group on computer (blue) to return to table while green group was finishing. S questioned about the bees. T told them they should be working with them next week. All ss return to tables with T and she asked them to do a firecracker to compliment themselves for hard work. T asks ss to count their cards and if they have 10 cards they are to stay after class to select a prize. If less than 10 cards they should line up to return to class.	
	2		1:03	End of tape. (One s stays after class to plant the extra plants that were taken out of the containers in the greenhouse.)	
1/21/04	3	T1	0:00	Ss enter room and are seated with their name tag envelopes. T welcomes ss to the class. Discussion of importance of getting enough sleep.	
	3	A1	0:03	T reviews with ss what they did the last week in the science lab. T uses go-around cup to call ss in most of this activity. S - We came back to measure our plants and you asked us the name of the box. S - We planted our plants and the name of the container was the cell box. T gives a card to each student who responded. 0:04 Did anyone look at the plants to see what was happening with the plants? S - the plants are getting bigger and bigger. T - so if they are getting larger what do they need more of? Ss- water. T- so what is it that we put the water in? What is this white container called? (T observes a s and tells him to think safety.) S - the seed? S - What's the question again? T - what's this container we put the water in? S - the water mat. T - you are close. T shows the class the water mat that is on top of the container. S - the water container. T - well, that's close. It's called a water reservoir. And there's one thing that we put in the water to hold down the	1B 3C 7C 8B 10B 11C 13B

				algae. S - what does it start with? T - an A. S - an algae sponge? T - you are close. It's an anti-algae square. S - that was exactly what I was going to say.	
	3	A2	0:08	T - Ok let's look at what's happening with our flowers. S - are those plants making seeds? T - yes. S had a question about the stakes. T tells them that the stakes help hold the plant up. T reads transparency to ss about flowers, growth tips, sepals, petals, pistil, stamens, pollen, nectar, pollinate, sperm, and eggs. T asks ss to repeat and sometimes spell the words. T adds one example of a bee or butterfly being attracted to the yellow petals. T - And guess what the eggs are? Ss - seeds. T - so are the bees and the butterflies doing a great job for the flower? Ss - yes. T - and what are they doing for us? Ss- they are exchanging pollen but they don't know it. T - and where does the pollen hang out on their bodies. Ss - on their body hair. T - that's what we're going to do. We are going to attach the bees to a stick and pollinate the flowers ourselves. S - can we look at the bees? T - When we look at our flowers today, our plants, we are going to look at the buds. The buds open up to become the what? Ss - the flower. S - what is the pistil? T - Ok let's look at it. T shows them on the diagram. We aren't talking about the gun. S - Are the bees from our lab? T - No I ordered them with all of the supplies. S - on this show called Maury this policeman shot this dog... T - is it pertaining to what we are talking about? S - no. T - We used to call it bird walking, that means you are getting off track of what we are talking about. Let's not do that. S - He gave this old lady a plant. S - You know when you called our names and we put a plant in those large jars and take them home? I helped my Dad with his garden. T - Yes and you get to take these home. S - can we sell them so other people can learn about them? T - no we are going to share these. Maybe something else that we do that we grow in the greenhouse could be sold for a project.	1C 2C 3A 8B 10B 11C 13C 15B
	3	T2	0:17	T draws a name from go-around cup and the group with that person goes to the computer first. Read about flowers on the computer today. Green on computer first with Teacher's aide. T works with blue side with plants first. T lets them look at the diagram of the plant on overhead. T gives each group their recording sheet from previous week so that they can read over the answers to the matching exercise before beginning their new session. Group 1 - 1 boy/2 girls; Group 2 - 1boy/1 girl.	
	3	A3a	0:19	Reporter for each group reads the responses to the matching exercise. T gave each student a card for participation during the reading.	1B 3C
	3		0:21	T gives the recorder from each group a log sheet for recording measurements of their plants and describes what they should do (label names & dates, sketch and write measurement of plant). T calls each group one at a time to measure their plants and look at the growth tip. We have about 10 minutes per group. S - s what is today's date? T asks group 1 to come look at the plants first. On the way a s notices a bug in a box on the counter. S - is that a real bug? Ooh. T - no,	4C 6B 13B 14C

				it was a preying mantis but it's dead now.	
	3		0:24	S - Look how much they have grown. Mine has buds. S - mine does too. T measures first plant for students. 7 cm. T allows ss to measure the others and reminds them to use the cm side. S - 5cm, 2 1/2, Ss other group brought their recording sheet over and said they were finished. T - you've already measured them. How do you know how tall they are? Ss erase their responses and wait to measure their plants. T - do you know how to write 1/2. T helps recorder with this. T brings squeeze water bottle to allow ss to water their plants. Comments that it's easier to use than the pipettes. T - you can see the growth tip because this part is dark and this part is light. S - one of the plants is open. T - The rest should open before this week is up. S - It's pretty. T asked ss to return recording sheets from this week and last week to her. Ss return to seats.	
	3	T3	0:33	T calls computer ss to line up (Green group) and asks the blue group to work on the computers. T complimented the green group's behavior during the computer time. Green group completed same activities as blue group.	
	3	A3B	0:34	T - I like the way you recorded your information so neatly last time. I'd like you to do that again today. T - when we get all these cards finished we are going to make a book with yarn to tie it together. S asks T to draw a four-cell block for her to draw the plants in. Group 1 - 1 girl/3 boys. Group 2 - 1 boy/2 girls. T measures plants for group 1. T- do you know how to write 1/2. S - yes that's what we're working on in class. 0:41 - Group 2 is looking at class lizard while they are waiting to measure their plants. Group one finishes measuring and works on putting their names and dates and completing the blanks on the page. Group 2, T - we put some plants in the greenhouse last week didn't we? We'll go out and look at them today. Ss and T measure the height of the plants. S-s How many seeds do you think our plant will have? S - about 5 or 6. 0:49 Group 1 boys begin to play some as they finish. Same boys notice a earth, sun, moon, model. S-s - He's saying that the earth goes around the sun. S - It do.	
	3		0:51	T takes ss to the greenhouse to see the fast plants that were planted outside. Ss were loud as they were lining up to see the plants, so T had them sit down until they were quiet. T - Think safety. If I see anyone talking, I'm going to take 2 cards. T - see if you see any buds. These green plants over here are kale for the animals. S - ooh a spider web. T - stop looking for spiders. Spiders are good in the greenhouse.	
	3	T4	0:54	Ss return to sit in classroom and T calls ss from computer to return to their seats.	
	3	A4	0:55	T used the Go-around cup to call on ss to respond to closure questions - For a two card bonus I need to know for each flower an insect gets attracted to what part of the body does the pollen stick to? S - body hair. T compliments blue side for their behavior on the computer as well.	1A 3A 8A

				She gave each of them a card. T - What has to open up? (no GAcup) S - the seed. T - What has to open up and then become a flower? S - a bud. Next week when you come in I'll have the bees attached to sticks so that you will be able to help pollinate the plants.	10B
	3	T5	0:57	T asks ss on each side to count their cards. Those with 10 can get a prize from the box. T asks each side to line up to wait for their teacher. Ss look at Tarantula as they line up.	
	3		1:00	End of Tape	
OVERALL COMBINED LESSON CODES					5C 9C 12C 16C 17C 18D 19C 20C 21A 22A

Posters: Fast Plant life cycle; cooking poster; solids, liquids & gases: various animal and planet posters; seasons of the year;
T- made posters: The Seed Challenge and Fast Plant growing instructions; safety constitution; tilt of earth and seasons; word wall (A-Z - with words studied in class posted alphabetically above letters)
Name of computer program: Learning About Physical Science: Matter; Learning About Life Science: Plants; CD-ROM, Mac-Windows, 2000 - Sunburst Technology Corporation

Appendix J.3 - STAM Record of Activities Pre-Observations Tee Jay

Date	Tape	A or T	Start Time	Description	STAM Code
3/20/03	1	T1	0:00	Ss return from Gym. T asks two Thursday helpers to pass out science folders for the class. T - Please take out the science reading section on the water cycle for us to review when you get your folder.	
	1	A1	0:02	Review water cycle lesson one from last week (when T was absent). T reviews the whole packet with them and asks the ss to fill in the graphic organizer bulletin board as they discuss. T - Where do fresh and salt water meet? What's that big word, the funny "e" word? S - estuary. T- Where do we find fresh water? Ss - fountain, sink. T- What do we fish in? Ss - lake, pond, river. T- Where do I find salt water? Ss getting excited and all wanting to answer- Salt Lake City, ocean, lake, (s tried to use creek, stream - t looking for river). T compliment - You guys really remember this. Use of fresh water: They use it for cleaning and drinking. How do you make macaroni and cheese? Elicits boiling and cooking with water. What do we use salt water for? S - Salt water for fun - T says how about recreation, is that what you mean? T tosses marker to ss. What does salt water have to do with oil (look on D-11). Look on the third or fourth sentence - it doesn't have to do with oil but that's OK. S reads and T says so what does water help us with. Helps to keep the planet warm or hot.	1C 2C 3C 7C 8C 9C 10B 13A 14A 15C
	1		0:09	Ss fill in graphic organizer for lesson 1. Bulletin Board in back of room. *Lesson 1 Water on Earth*: *Types of water*; ________ *Where found A. B. And C. Uses: D. E. and F*. (place for fresh and salt) *Where do we meet?* (Estuary) - *between salt and fresh water*. *Lesson 2 The Water Cycle: How Water changes and Moves 1. _______ water changes from a ___________ to a __________. 2. _________ water changes from a _______ to a _______. 3. _________ Liquid water falls to the ground as _________. (1-3) arrow down to the water cycle is the movement of water from _________ to ____.*	
	1		0:15	T demonstration for lesson 2. Shows bottle of water to ss. T - Where do the bubbles of water come from? It comes from the water in the bottle. So would that mean that water moves? Ss - Yes (a couple of ss). T - There are 3 parts of what water does. Evaporation, what's the sweat called "con.."? (Ss try conduction, convection) and one s got it right -condensation; What happens when that cloud gets so full? - think of a cotton ball. What's it called when it rains? S - Precipitation	
	1	T2	0:20	Put lesson 1 away and T passes out lesson 2.	
	1	A2	0:21	T helps class set up a demonstration described in the reading. Put water in cups, measure, and	1C

				then measure again the following day. T compliments a s on behavior. T asks a s to get her 2 rulers to measure the height of the water in two cups. T asks the s to tell her the height of the water. S tells cms and then T asks for inches. T - Ok, write this on the bottom of the page. Blue = 3 1/2; Green = 2 1/2 Do you think it's going to change alot between today and tomorrow? What's it going to do - vibrate, no it's going to evaporate - take a guess as to how much you think it will evaporate. Be your own scientist, you are a great scientist. Everybody finished guessing? Do you think the water in the cups will evaporate the same way? S - No, one s said she thought because there was more water in one that it would lose more. One said the same. T - why? Why do you think that blue will go down more than the green? Do you think that they will evaporate the same or differently? One s mentioned the color difference in the cups. T- The darker the color how does it affect it's temperature? Would you wear black or white on the baseball field? Most say white; S - because black attracts sun and makes you hotter.	6C 7C 8C 13A 14A
	1	T3	0:28	Please open and make sure that you are on D-16. Reading out of packet - plan to do pop so pay attention. (pop means that the s can choose who to read next)	
	1	A3	0:29	Ss read section 2 on the water cycle and complete the graphic organizer for the section. T stops reading for questions and elaboration. T - What happens when you boil water - What do you see at the top? S- steam. T- says that's the vapor. T - Look back at graphic organizer - can we answer the statement water changes from a blank to a blank. Not yet. Same s continues reading or has the option to pop (he continues to read). Now can we answer number 1. Evaporation is water changing from a liquid to a gas. (A s threw a piece of paper.) T - I hope you are reading along because he could go pop at any time. 0:34 Pop to another s (couldn't hear girl on this side of room). T - Condensation is changing from a gas to a liquid. So can't we do number 2? Ss say yes and reader writes responses on graphic organizer. Mark page in booklet where we finished reading. T - you all are doing a really great job.	1C 2C 3C 7C 8C 13A 14A
	1		0:37	Further discussion. T asks for ss opinion. What do lakes and oceans have to do with evaporation and condensation? Where do the clouds get the water from? Why is it important for us to have water in the oceans and lakes? Remember when you were eating the snow - what did I tell you about that. S - It wasn't safe because ducks doo doo in it. T - Remember that all of this water mixes together - so it may not be safe to try to drink the rain or snow.	

				S -What about snow cones? T - Those are just crushed ice.	
	1	T4	0:40	T calls on one group of ss at a time to return their science folders. Group names (student-selected) Lionhearts. Fairy Goddragons, Mr. Dr. Pepper, Mrs. Butterfly, Candy Store, etc.	
	1		0:43	End of Tape. Last s had returned folder.	
3/21/03	2	A1	0:00	T and ss compare and discuss the water levels in the cups from the previous day's activity. They had been placed in the window. They also completed the graphic organizer. T - Elicited three terms discussed yesterday (evaporation, condensation, and precipitation) and wrote them on the board. T -You made some predictions about evaporation yesterday. Blue cup measured at 3 and 3/8 (just under 3 and a 1/2); The green cup measured at 2 7/26 (just under 2 and a 1/2). S - How did it go down - did it melt? T says what is by the window that provides heat. She compared the activity to the ocean and asked how that would compare. Ss decided the ocean would lose more. T pulled down world map - what color do you see mostly - water or land? How many little cups do you think would fill up the ocean? T- continues to ask the ss to use the three terms. They finished the graphic organizer for lesson 2 and talked about forms. T asks one s to complete the last phrase (ss comment about him using his left hand). (T - requires that they raise their hand before she will respond to them.) Liquid water falls to the ground as... S called on has trouble and she calls on a second to answer - rain. Water cycle begins with: s says the ocean; T says use Earth's surface; and it goes to, s says clouds or sky; and then it falls to the.. s says ground, T -says use Earth. One s said it could come down as snow. T - I'm glad you said that, how else do we know water comes down as: rain, snow, ice (sleet, hail).	1C 2C 3C 6C 7C 8B 13A 14A 15C
	2	T1	0:14	T passes out Yellow construction paper. Ss talk about their different experiences with extreme precipitation.	
	2	A2	0:15	Ss make a pyramid (Dinah Zike folds) and then write and draw the parts of the water cycle on each face (evaporation, condensation, precipitation). T says, 1-2-3, Eyes on Me in order to get their attention. T - Do you remember how to make the pyramid? Fold it over and then cut it like a burrito. Fold again the other way. Looks like a diamond or a kite. You are going to need scissors (from t's desk or their own). Then cut one line to the middle. T demonstrates folds and cuts. ("Butt in chair") Ss stay seated and T staples twice to make the pyramid.	1B 6C 7C 9C 10B 13A 14B
	2		0:21	Pyramids are made and T calls for attention again. T - Each face of the pyramid (remember face from geometry) is going to be one of the main parts/elements of the water cycle. Ss get a marker from the marker bucket. S - How do you write	

				element? T - When finished writing the words, draw a picture of what each should look like. (Oral instructions for this part - but there is a diagram drawn on the board from earlier) T- what is the most important thing we would show for evaporation? What would the evaporation look like? It floats up. Water and then movement of water up. I want to see water, arrows, and sky. Condensation: s - it's going to get bigger; T - clouds getting fatter; Precipitation: s - rain coming down (T - or sleet, snow, ice, etc.). Some ss ask what they are after it's been explained. T - I only have 2 ears designed for one person. Ss start crowding around T and she asks them to sit and she will come to them. 1-2-3, eyes on me. Put your name on the inside. 3 boys are at computer. (T says that Carlos is the only one that's supposed to be there.) T circulates and answers their questions. T - I really like the way that she drew condensation. She is showing the clouds getting bigger.	
	2		0:30	You have 5 minutes to finish up. When finished bring it up here and put on my stack. S - Can I go...? T -No you may not.	
	2	T2	0:35	Clean up your area, bring scissors and markers back.	
	2	A3	0:38	Ss continue reading from yesterday where they left off. D17. One s read some and then popped (she's not ready she's still finishing her pyramid); popped to another s.	1B 2C 3C 7C 13A 14A
	2	T3	0:48	T assigns the ss to answer 5 questions at the end of reading on a sheet of paper. T - let's look at them first and find out where we can find the answers. One s was at pencil sharpener - should you be there now? (no because she is talking). Ss are asked to label their papers.	
	2	A4	0:50	Ss work on 5 questions and are told to finish for homework if necessary. T - The sharpener is open now and you may begin. You know what that means we have to change our graphic organizer again. One s needed to borrow a pencil and he had to give his shoe to T. Can get it back when he returns the pencil. All ss working on assignment until finished or dismissed.	1B 9C 10B 13B 14A
	2		0:55	End of Tape.	
4/1/03	3	T1	0:00	T asks ss to put things in their save folder and to clear their desks. She asks two helpers to pass out 3 index cards and 1 sheet of white construction paper. (T - Who has not whined and has earned all of their checkmarks - to be helpers.)	
	3	A1	0:03	Review of Water Cycle (1st science lesson after returning from Spring Break) T writes "What are the 3 parts to the water cycle?" on board. T asks for s volunteer to read the question. One brand new s today. S volunteers give the 3 parts while the T writes it on the board. Who can give an example of evaporation? S says isn't that when water goes up; when water rises	1C 2C 3C 7C

				into the clouds. T - says from where (rivers lakes, etc.); can we see this water. Ss say no. T - What is this water called when we can't see it? T gives prompts - and tells them water vapor rises (reminds of boiling water). Writes on board - water vapor rises from rivers and oceans. Who can tell me about condensation? S - clouds get bigger and it starts to leak, it starts getting bigger (with T prompts) T- writes water comes together in the clouds. T - So what is precipitation? S - says on the ground. Rain. T - is rain the only form? Ss offer example - hail, sleet, snow. T writes - water falls to ground as rain, sleet, snow, hail	8C 9C 10B 13A 14A 15C
	3	T2	0:08	We are going to make a display board (*Dinah Zike* fold) for our information like we did in social studies. We are going to display our information about the 3 parts.	
	3	A2	0:09	Ss make a display board and write and draw the 3 parts of the water cycle as directed by T. T - Take white paper and make a tri-fold. She asks a s to go around and help who finishes quickly. All hold up when finished. Fold the 3 green cards with a hamburger fold (short and fat fold). Raise your hand when you are finished. T puts glue on back of all three cards for them to put on the display board. T asks helper to help ss see where to put the cards. One card per fold on display board.	1C 6C 7C 9C 10B 13B 14B
	3		0:14	Ss begin writing the three parts of the water cycle on each card at T prompting in the order that they were written on the board. T allows a s to put glue on one card (teases him about being careful). T - helps a s correct his cards because he had glued it incorrectly. Compliments a s and asks him to pass out two cotton balls per s. S - Do we write evaporation right here? T - You notice I only gave you two cotton balls - you are going to have to share.	
	3		0:18	Now you are going to have to draw pictures for me. Where do the pictures go on the green or white part? S says white part. (one s did not hear her because he was being loud) T- what do you think you will need to put on the green part? Ss say what the word means. T- the descriptions are no longer on the board so you will need to use your own words. T- where should you look if you don't know what they mean? Ss - (dictionary, social studies) and in the science folder. S - What do we need glue for? T asks another s to say why? S - to glue the cotton balls. 1st s says oooo. T - I like the way ____ is working so hard. Ss get crayons for pictures and markers - don't need permission. When T needs their attention to give an announcement - 1-2-3 Eyes on you.	
	3		0:21	T puts a yellow piece of paper on their desk - tells them that they will use it later and to save it. S - Can we use markers? T - it's up to you, this is your project. S - can I see your picture? (to T). T - I can't let you see my picture, I want this to be your interpretation. One s decides to use Kleenex for clouds. T says that's a good idea.	
	3		0:26	T - About 2 minutes to finish up. One s needs a pencil - he has to turn in shoe to get one. T stays	

				seated and ss bring paper to consult with her. She tries to elicit the answers from them.	
	3		0:28	Ok you've got 3 minutes. Tells s he has plenty of time and she thinks he has done too much talking. (Ss are talking throughout exercise but on task and completing work.)	
	3		0:30	You have one minute. (Intercom - do you have a weedeater - no but I have a mower, etc.) All right time is up if you are not finished take it home for homework. New s - I don't have anything at home where I can do it. T- says you can borrow a s's folder. T counts back 10 - 1. They write their name on the back of one of the folds (as prompted) and turn in if complete.	
	3	T3	0:32	T - you should be seated - T compliments those who are seated with heads down. Points to yellow piece of paper - used for exit ticket - Put your name on it.	
	3	A3	0:34	Ss complete an exit ticket. They are asked to write the 3 parts of the water cycle? T told them to not worry about spelling. T - Don't cheat off your boards. S- Off of what boards? (Intercom Announcement - Max Thompson visit tomorrow - Ask ss to pick up trash off of floors) T - I still need some exit tickets.	1A 9C 10B 13A 14A
	3		0:37	End of Tape. Science is finished, ss are asked to take the display board home if they are not finished.	
OVERALL COMBINED LESSON CODES					4B 5C 11C 12C 16C 17C 18C 19C 20B 21B 22C

Science is taught on Tuesday, Thursday, and Friday - Spring Break - 3/24- 3/28
R - 3/20/03 - Tape one S groupings - Group 4; group 3; group 3-4; 4 singles; 9 boys, 5 girls (5AA)
Science Bulletin Board with concept map - graphic organizer; Journal topic on board: Tomorrow is the first day of Spring. What does Spring mean to you? What types of things can you do in Spring?
4/1/03 - Seats separated - different from the last two times. - seats put back into the group spots at the end of the class

Appendix J.4 - STAM Record of Activities Post-Observations Tee Jay

Date	Tape	A or T	Start Time	Description	STAM Code
11/5/03	1	T1	0:00	T asks s to pass out science journals. S - Can I help her? T - no. Put today's date on a clean sheet of paper.	
	1	A1	0:01	T - We've had our antfarm going for 2-3 weeks now. I want you to write in your journal what you think it is like being one of the ants living in the farm. S - What? T - tell me what you do all day. If you were an ant, not like an ant in the yard, but an ant in our farm, what would you do all day? Ss quietly write their thoughts in their journals.	10C 11D 14D 20B

				0:07 T - time's up. T - S (boy) will you share with us what you've said? Stand up and read to the whole class. S - I would walk across (inaudible). T- so you would see lots of people and walk across other ants? S - No (inaudible). T - so you would walk over the green fixtures that are part of the farm? Will you share with us what you wrote? S - I would play all day, go across the bridge. 0:08 T - share your story with your brain buddy. If I were an ant I would not like it because there would be nothing to do. I would probably sleep all day or go to a different part of the ant farm and play with other ants.	
	1	A2	0:10	T - We've had our birds, fish, and ants. S - birds? T - remember our birds (given away). What do we call those areas that they live in? S - a cage. S - a home. S - an ecosystem. T - An ecosystem. What does that mean? Ss hands go down. T - Don't look in your books. We're not going to go for definitions. I'm going to hold you on that thought. T - on a new clean piece of paper in your notebook, I want you to come up with some synonyms for, what are synonyms? Ss - words that sound the same but mean different things; opposites; words that mean the same thing. T - words that mean the same thing. I want you to write on your paper words that you can think of that are synonyms for Ecosystem. S - Can we put like house? Ss question directions. T - god gave you two hands, raise one. You've told me the antfarm is an ecosystem. We've discussed that our classroom is a type of ecosystem. Ss begin to realize what they should do. T - you can talk with your brain buddy. T - I see cage, fishbowl, home. 0:13 If you have at least one synonym, thumbs up. Most ss raise their thumbs. At the end of this lesson we are going to come up with a definition for ecosystem in our own words. Not something from the back of the book.	1D 2D 3D 4C 7D 8D 10C 11D 13C 14D 15C 20C
	1		0:14	Turn your paper that you have been writing on hot-dog style. T demonstrates holding the paper horizontally. Write living, not living, and not sure on the same piece of paper across the top. (T has predict written on board - but does not discuss this with them) 0:15 If you were to go out and shovel a pack of dirt from your yard, discuss with brain buddy the kinds of things that you would find that are living, not living, and things that you are not sure. Let's do one together. S volunteers worm. T - would that be living, not living, or not sure? Ss - living. S - What are those things that can roll up? T - Pillbugs. S - no they are like little circles. T - You might know them as rolly pollies. S-s discuss if they think dirt should be living or not. If you have at least 5 things on your list thumbs up. Jayla had a good comment, dirt doesn't count. S - does it? T - I don't know, you need to think about it. One group's list: living - worm, rolly polly, ants; not living - dirt, roots, grass, moch (mulch?),	

				seeds; nothing in the not sure column	
	1	T2	0:19	One person from each pair needs to come up and get a magnifying glass and a tray for each of you. Each student should have the materials. Leave magnifying glass on the tray and line up in numerical order with tray. T walks ss to the school courtyard and asks them to sit on the picnic table and wait for further directions. 0:23 boys and girls separate themselves without asking. T asks them to come get a trowel out of a bucket. S- what's a trowel?	
	1	A3	0:24	T describes their task. They are to dig up three scoops for their tray (has been a rainy day and it's easier to dig). T directs boys to one side and the girls to the other side of the courtyard (200 feet apart??). T advises ss when they have enough, they need to return their trowel and stand by the door to return to the room. T helps one boy dig his dirt. S - I have a worm in mine.	1D 2D 3D 4C 6D
	1	T3	0:26	Ss have collected their dirt in their trays and they walk back to their classroom.	
	1	A3 continued	0:29	T asks ss to use their magnifying glass to look at things in their tray and use their pencil to move the dirt around. T gives each s a piece of newspaper to put under the tray. T asks ss to draw pictures of what they observe in their notebook. S - all I see is mud; I see a worm. T - don't forget to do pictures. We do not want to kill any creatures. S - look it's a bean plant, what is this? T - now a lot of you have snails, ants, and beetles, what are these creatures doing with the dirt and with the plants? Ss - eating, polluting. T - they are doing things inside of their habitat? So what can we say an ecosystem is? S - a habitat. T - so what do they do in this habitat? Ss - move, eat, play. T - what do we call all of those things? S - insects; interactions (T whispered word to her). T - What is an ecosystem? It is a habitat like Caleb says where what happens? Interactions between animals and what? Ss - dirt, different animals. T - can we say between animals and what was that other word? S - organisms. T - this definition needs to be written on your page. On board: Ecosystem - a habitat where interactions between animals and other organisms occur. Ss continue to look in their trays. T reminds ss to write if what they are finding is living or nonliving. S - T I can't find any bugs or anything. T - you do too. Another s comes to help her out.	7D 8D 10C 11D 13C 14D 20C
	1		0:38	T asks s to share an idea she had with the class. S - Ss with bugs can share theirs with those who don't have bugs and see if the bugs like the different dirt. T asks ss to compare the girls and boys dirt. The girl's dirt is wetter. Is there a difference in what you find in each kind of dirt? One s had shared a bug with a different s. S - the bug crawled into the dirt and found a home. T - So was your experiment a success? S - yes.	
	1	T4	0:41	Ss asked to return to their desks and focus on T.	

	1	A3 continued	0:42	T asks ss to discuss the living things they found in their ecosystem. S - ants and these little gray things. T - what did you call them? S - fleas. S - worms and plants; centipede, slug, and a worm. S - I didn't find anything living. T - would you say that your dirt is living or nonliving? Ss - respond living and nonliving. T - What makes you say it's living? calls on a s who felt it was living. S - it gives something to the plants and bugs that live in it. T asked another s to share why he thought dirt was not living. S - I don't know. T- you have to have some sort of basis. S (different) - It don't move, or talk. T - plants don't talk. Maybe we need to continue this as our question for tomorrow. T writes, "Is dirt living?" on an assignment board next to science.	
	1	A4	0:44	T asks girls to return their dirt back to the same area they picked it up from. Some ss continue talking about whether dirt is living or not. T asks boys to write something that they learned today in their journals. Tell me why? T - I know that K.W. and Rachel conducted their own experiment based on Rachel's question and I think tomorrow we will continue with our question, is dirt living? S - If there wasn't any such thing as dirt we wouldn't (inaudible)? T - We are going to continue with this tomorrow. T asks ss to take everything from today, staple it, and put their number on it.	11D 13C 15C 20B
	1		0:48	Girls are returning and T asks a few girls to take the boy's trays back for them. T asks girls to write what they learned today in their journals. T asks ss to put the papers in their folders when they are finished, and return their trays and magnifying glasses.	
	1		0:51	Girls return from the second trip to return dirt. They had seen a leech in the hallway, were scared, and squealed. T lets ss who just returned write what they learned on a piece of paper. T - I like the way that Chris has his things on his desk ready to go, but I don't have your folder or your agenda.	
	1		0:53	End of class	
11/6/03	2	T1	0:00	T asks s to pass out some tickets for ss who are doing what they should be doing.	
	2	A1	0:00	Review of what class had discussed yesterday. T - who can remind me what we talked about yesterday? Many raise hands. T calls on one S. S - Ecosystems. T - Do you remember our definition of ecosystems? Few raise hands. T - it was the way that animals, it was that "in" word. Interact. S - interactions. T writes definition on board - the way animals and organisms interact. S - we haven't done Language. T - and you miss it that much and are willing to lose points for calling out? S - We talked about living and non-living. T - that brings us to a question that we had yesterday when we were talking. Who remembers that question? S - Is dirt living? 0:04 T asks ss to create a T-chart on a sheet of paper. She models on white board - living and nonliving on each side of the chart. Make another line in the middle of the paper. Talk with	1D 2D 3D 4C 7D 8D 10D 11D 13C 20B

				your brain partner and come up with some things that tell you something is living or nonliving. What are some characteristics of something that is living? Raise your hand. S - moving. T - air moves, is that alive? Ss - no. T - so you need to come up with some other things that describe living things. T - I need to hear you talking with your brain buddy about this. T - I'm looking for mostly verbs, not nouns. I'm not asking you to give examples. 0:07 T - Give me an example of something that is living. S - cat; opposum, person. Add these to the T-chart on the bottom half. What are some non-examples? S - a toe. T - Someone said that a living thing grows, do nails grow? Is a nail living or non-living? Ss - living (misconception - not addressed). S - another example is glass. T - give me some characteristics of nonliving things. S - it's not moving or it's very still. T - But, does mold move? Ss - yes and no, it spreads. T - mold spreads, but does it move? It grows. S - If it grows it moves. T - Does it move like we move? It can raise up one of it's spores and move? So if mold grows is it living or nonliving? Ss - living. T - Why? S - because if it grows it's a living thing. 0:11 T - you need to discuss some characteristics of nonliving things with your brain buddy. 0:12 T - give me some examples of what you came up with. S - talks. T - a phone talks? Give me some things that you as a living thing do? We already have grow and we know that living things can be moving or be still so we can't put that. What else do we do? T writes on board as ss respond. S - breathe. T - there's some form of oxygen exchange. What do I take in when I breathe? S - air. T - or nutrients, and then I'm spitting back out things that I don't need. S - carbon monoxide. T - We have some way of releasing waste we don't need and keeping what we need. What else? What are we hoping will happen in our fish tank? S - have babies. T - so are you saying that a big tree that is living can have a little tree. Ss- yes. T - what did our sunflower do with it's seeds? Ss - grow. T - and what happened? Ss- they grew. T - we call that reproducing. Using just these three things (grows, takes in nutrients/releases waste, reproduction) answer the question is dirt living. Turn your paper over write the question, answer it, and give me an explanation based upon what we've talked about and what you've put on your T-chart. S - inaudible question about plants. T - but do they reproduce? It has met one of the requirements of living things. T tells a couple of ss to do the assignment and stay on task. Write "I think dirt is living or nonliving because..." S - doesn't dirt go to the bathroom? T - then I'd like to see you go on Letterman and show that. We said if dirt was living it should do at least one of these things. S - It grows. T - so if I take one piece of dirt and put it on my counter I will have 5 or 6,000 more pieces of dirt in a year? S asks T to go to bathroom - T gives S pass.	
	2	A2	0:20	T - If you think dirt is living, thumbs up? Many raise thumbs. T asks those that think it's living to go to one side of the room while those who think it's nonliving to go to the other. 4 think	1D 2D

				nonliving and the rest (10 or 11) think it's living. T describes that they are going to have a debate. T - what is a debate? S - like at elections. T - What do people do at a debate? S - they vote; they say what's true or non true; two people go to a place and decide if you should do this or that. T - so do they talk? S - yes. T - You need to decide on the first spokesperson for your group. We will rotate spokespeople. They need to speak clearly, think clearly, and argue a point. Each team sends one person to stand in front. T asks living side to present their argument. T asks s to read what she wrote. S - Dirt is living because it doesn't have to move to be alive and because living things live in it and because it grows seeds. T asks nonliving speaker to tell her if she is right or wrong based upon what was said. S - wrong. T - why? S - Because dirt don't move. T - come back at her. S - It doesn't have to move to be alive. T - what does it have to do to be alive? T turns nonliving advocate to the board for a hint. S - grow. T - Say it has to grow in order to be alive. S - says this. T tells living advocate to come back with an answer or the other side will get a point. S - Dirt can grow. T - How? S - well little dirt can (inaudible). T - but that's not growing, the two pieces of dirt already existed. Ok a point for the nonliving side. 0:24 Change of advocates. Nonliving first - S -Dirt is nonliving because it doesn't move and it doesn't use the bathroom. Living advocate S - It doesn't have to move to grow. Trees and stuff feed off of it. Other S - That doesn't mean it's alive. T - repeat back to him why you think it's alive. S - I think that dirt is alive because trees and flowers feed off of it. S - That's silly. T - that's not how the argument is done, it has to be based on logic and facts or they get the point. S - I don't feed other things. S - But dirt does. T - But he is saying that he is alive and he doesn't feed other things. Counterargument? S - this is harder than I thought. You may not feed other things but dirt does. (to teacher - you are being difficult). Non-living earned point again. 0:26 Go back into your groups and regroup your arguments. S on living side - says, but midgets don't grow. 0:28 Send a new advocate. Living advocate - it's living because it can reproduce other things. T - He's saying that dirt can help other things like when a flower grows, is that what you are saying? Non-living advocate - but dirt doesn't feed other things. living S - this is hard. T - does dirt actually feed other things? Ss - yes. T - have you ever seen a plant die that is in dirt? Ss - yes. T - then dirt wasn't the only thing responsible for feeding it. Continue. Living S - It can keep the roots alive to the plant and helps the water get to it. Non-living S - When a plant dies... T - point goes to living side. 0:30 New advocate. Non-living - S - It don't move. The dirt don't make it alive, the seed grows in it, water helps it. Living S - sometimes you can make things grow without water. We don't always water living things. Non-living S - the rain does. Living S - what if it don't rain. Non-	3D 4C 6D 7D 8D 10D 11D 13C 14D 15C 20C

				living S - then it don't grow, it dies. Living S - If you put a seed in dirt the sun can help it grow too. Non-living S - But what about at night? T - come back on topic. Living S - If dirt dies, you can't grow nothing. Non-living S - It wasn't living in the first place. Living S - But if you don't have dirt you can't grow anything.	
	2	T2	0:33	T - give yourself two claps and have a seat. Good job. This was your first opportunity to do a debate. It's where you have two sides to an argument and you have to stand up and you have to give reasonable answers as to why you believe what you believe.	
	2	A3	0:34	Does anyone want to change your answer from what you believed, raise your hand? No one wanted to change their mind. (To me - Should I just let them fester a bit?) S - I want to debate again. Me - What about the things that help us to survive, like refrigerators and microwaves are those alive? Ss - no. Me - what about our houses? Ss - no. T - What do we have that a refrigerator may not have? S - energy. T - but wouldn't a refrigerator have energy too? S - we have blood circulating. T - what about fish? Do they have something similar that pumps blood? Ss - yes. T - what about cells, remember when we looked at the onion skin cells, and we saw the cytoplasm? Ss- yes. T - and all of the movement of the cells causes what? Life. S - but everything has cells in it. T - but if we go on our hot and cold theory, is dirt alive or dead? Ss- mixed. 0:38 (Me) - One important thing that all living things have to do is that they can reproduce. Can you take two pieces of dirt together and have them make new dirt? Ss- mixed answers. Me - you can make mud. What you might want to do is get some dirt and measure it and weigh it and keep it in the classroom for a month. If it was living what would it do? S - It would keep on growing. T - We could do that. Have we answered our question. S - mixed responses - yes it is alive. No it's not. T - Your extra credit project will be to design an experiment - you can do exactly what was suggested or you can do something different. I will want to see your measurements. S - can we debate again? T - not right this moment.	1D 2D 3D 4C 7D 8D 10D 11D 20B
	2	T3	0:42	Take out your science books. We are going to do some reading about ecosystems. Turn to D20. We left off last week talking about predators and prey. 3 Ss return from resource and join class.	
	2	A4	0:44	T asks a s to read. S reads about consumers and predators. A couple of ss look for book. T - asks where some of the books have gone to. S - points out where he noticed some. Continues with lesson - T reminds ss of picture of a bird w/an earthworm. A visitor enters the room to ask the T something. T asks class to continue reading silently. Girl picks up reading where she left off. T stops reading periodically to discuss meaning of words. T stops s reading and points out the lynx in the picture for ss. T - what do the words abundant and scarce mean? T and class talk about it. Let's look at the graph. What does the blue line stand for? She asks ss to interpret	1C 2C 3C 7C 8C 10D 11C 20B

				different points on the graph. What does it mean to let the land recover? What would happen if we had goats in our courtyard and they ate all the grass? Could the goats survive and what about other organisms? What if we moved the goats somewhere else for another source of grass? What else moves around like goats? Ss - horses; geese; bees; bear; cow; lion; hummingbird.	
	2	T4	0:53	Close books and get out your T-chart and write down something that you learned today. Make sure your number is on your paper please.	
	2	A5	0:54	Ss spend time writing. S - Is dirt living? T - I'm not going to answer that, that's your extra credit project. S - If you put a teaspoon of dirt and put water in them and more dirt (inaudible)? T - It might make mud but you've added something. The question was if it reproduces it only takes dirt and dirt, it doesn't add water.	10B11D 13C15C 20C
	2		0:56	End of class	
11/7/03	3	A1	0:00	T - What were talking about yesterday in science? S - Is dirt living? T- Did we come up with an answer? Not really, it's up to you to design an extra credit project to determine if it's living or not. Class reviewed the reading about predator and prey relationships.	
	3	T1	0:02	Office calls for helpers and T asks ss to take out their books. Turn to D- 20 One s complained about not being chosen to help in the office. T addressed quickly.	
	3	A1 Cont.	0:03	T asks ss to describe the relationships between the hares and lynxes. T - What happens to the lynx when the hare population is down? S - they die out. T - Why? S - they don't have any food to eat. S - what about other food? T - That's a good question. T asks another student to rephrase the question. S - If the rabbit is gone what about some other food like deer? T - Are you asking if the lynx will choose a different food? Remember when we talked about the owl and how it chose a different food? S - Yes it works like that.	1C 2C 3C 7C 8D 10B 11C
	3		0:05	T - Do you remember the pictures we created of carnivores, omnivores, or herbivores? Ss - yes. T - What is a lynx? S - carnivore. T - From what we've read what do you think the main source of food is for the lynx? S - the rabbit. T - but if the source of rabbit is low, the lynx will probably choose something else. T compares to how humans will eat more pork if cows are scarce.	15C 20B
	3	A2	0:07	One student reads from the book as others follow along. Reading about symbiosis. Between animals and microscopic organisms. 3 types are explained. T - Who can look back and tell me in their own words what symbiosis is? T calls on one student who is unable to answer. T directs her to locate and read aloud the meaning of symbiosis. T suggests a way to reword the meaning. Parasitism - compared to maggots in ant farm. Which is the host and which is the parasite? S responds correctly. Book example - flea/dog.	1C 2C 3C 7C 8C 10B 11C

				0:13 T asks brain buddies to think of some other examples in which one organism lives off of and harms the other. 0:17 Ss share their ideas: lion/zebra; Shark/dolphin; Hornet/spider; Cat/mouse; humans/bears (T comments that we do not eat bears for our survival). (0:19 One s called to the office for early checkout.) Continue reading about commensalism - One species benefits and the other is unaffected. Book example - spider on a yellow flower. T disagrees with statement in book. Will the pollen be spread? S gives an example of how pollen is dispersed. Seond book example - Wildebeasts and egrets. T - described another example of Whales and fish. S - Why does a dolphin kill a shark? T - A dolphin will not kill a shark. 0:24 Mutualism - both organisms benefit - pollination of flowers by bees. Other book examples - Leeches on rocks; fungi and algae 0:27 T asks ss to talk with their brain buddies to discuss something in our world that we gain something from and give something to. T was searching for human's mutualistic relationship with plants & trees - exchange of Oxygen & carbon dioxide. 0:28 T asks ss to share. S - Another person - you give them something, they give you something back. S - Trees. T - Trees. What do we give trees? S - Carbon Dioxide. T - And what do trees give us? S - Oxygen	13C 15C 20B
	3	T2	0:29	T asks ss to answer 1 & 2 on page D - 23 with brain buddies on a piece of paper. 1 paper per group	
	3	A3	0:30	S - Do we have to write down the question? T - no. S - Can we use one piece of paper to put all our answers on? T - Yes as long as all your names are on it. Ss working on questions with their brain buddy. 1. Like other organisms, you interact with your environment and are part of an ecosystem. Give three examples of ways that you interact with the living and nonliving parts of your environment. 2. Think about the foods you eat. Would you classify yourself as an herbivore, a carnivore, or an omnivore? Explain your answer. 0:33 S question about # 1. T addresses whole class - remember we've talked about our classroom as an ecosystem and we interact with each other. Think of 3 examples of how you interact with living and nonliving things in this classroom. What's in this room that is living? S - spiders, plants, fish, ants, people. T observes student work and comments - don't just put down spiders, plants - tell me what you do with them. Students working in groups and one student writes the responses for the whole group on one sheet. (app. 4 groups?) 0:39 T- You should be moving on to question number two if you have not done so already. Ss in	1C 2C 3C 7C 10B 11C 13C 14D 20B

				one group begin discussing the difference between herbivores, carnivores, and omnivores. T discussing ideas of one group - describe why you think we are omnivores. Does everyone eat vegetables and meat? Ss- no. So would everyone be considered omnivores? Ss - no.	
	3	T3	0:43	T - sounds like everyone is done. Put your papers in your purple folders and show me ready position. Take out your Shortstuff journal out on your desk. Put today's date for your next entry.	
	3	A4	0:45	Tell me what you have learned in this unit - we have talked about alot of things when it comes to predators and prey, omnivores and herbivores, consumers and producers. You need to have at least one paragraph. A paragraph includes how many sentences? Ss- 4 or 5. T - at least 4. You are welcome to use your book if you need it. S - What do we do? T - You need to ask your partner, I'm not repeating it. All ss work quietly on their paragraph. 0:47 Give examples of things you thought were cool, things you liked and didn't like, things you could do to make it better. 0:50 Two ss return from resource. S - Eric was cussing. T talked with the student quietly and asked him to sit down. Class continued to work throughout.	10B 13C 20C
	3		0:53	End of Tape. Ss are asked to start cleaning up their areas and bring agendas to have them signed. Two safety patrol ss exit room	
OVERALL COMBINED LESSON CODES					5D 9D 12D 16D 17B 18C 19B 20C 21B 22A

Store-bought posters: Writing as a process (5 steps: prewriting, drafting, revising, proofreading, proofreading), posters of presidents, American history posters (Civil War); bulletin board about writing - 5-point rubric; common proofreader's marks

Teacher-made posters: Focus questions for Language arts, reading, spelling; respect posters; bulletin board w/lunch schedule posted; bulletin board w/concept map for Language Arts topics; bulletin board w/days of the month posted as roman numerals; poster of what a correct assignment would look like.

Antfarm, aquarium (1 gallon); 1 computer

Appendix J.5 - STAM Record of Activities Pre-Observations Daphne

Date	Tape	A or T	Start Time	Description	STAM Code
4/15/03	1	T1	0:00	T - waited for ss to return to room.	
	1	A1	0:01	T - asked ss to describe what they had been recycling this semester.- ss- notebook paper, magazines, bottle (T- what kind?), plastic, newspaper, and cans	1B 2C
	1			Discussion of plastics and vocabulary. T - Today's focus is on plastics. Let's look at some vocabulary words that we will be using. Plastics, polymers, resin, flexible, rigid - written on white board. Ss practice pronouncing w/T. Scientific word for plastic is polymer. You've heard of poly before, where? Ss - polymer. What do you think poly means? S- guess shape, figure. T- poly means many. 0:04 T brought in history. Talked about pool balls made from ivory. T- why is it not a good thing to use ivory? S- because ivory is elephant tusks. T- and you have to kill the elephant. Story - elephant's tusk - ivory; scientists messed around and used plastic instead made from tree sap (resin). T - gives examples: goody box, nametag, and grungy pencil holder; talks about which ones are flexible or rigid. Asked ss to give exs. Silverware, bottles, computer parts, lamination, rulers (T asked them to say if the examples were flexible or rigid).	3A 4C 7C 8B 10B 11C 13A 15C
	1		0:08	T describes work at Zany Brainy (a toy store)... I love toys, how many of you have toys made of plastic? Describes - *Jungle friends* - magic grow. It will grow 5 times bigger. T questioned what way it would grow bigger. To get it to grow you have to put it in H2O. What's H2O? - ss say water. 0:10 I thought we would measure the length, height, and mass. As scientists are we going to use the English or metric? Ss - Metric. T- Good all scientists use the metric. So we will use mm as the unit for length. How many mm are in a cm? Ss- 10. T - So if I have 3 cm how many mm is that? Ss 30. T- How are we going to find out the mass, how much it weighs? T suggests they use the chart. One s volunteers grams.	
	1	T2	0:12	Before beginning the experiment we need to learn more about plastics. She passes out a handout to each pair of ss. T gives ss about 8 minutes to read and then they will discuss it with teacher.	
	1	A2	0:13	SS read the assignment out loud to each other, except for one group of four they read it silently to themselves.	3A 13B
	1			While ss are reading, T wrote on white board: 3 Write three facts you learned. 2 Write two things you still want to learn. 1 Write one way you helped your group today. (+ a smiley face).	14B
	1			T circulates room to talk with groups some. T passes out supplies (paper rulers (2 per group) and	

				data recording sheets as they read) 0:19 - is everybody done?	
	1	A3	0:19	Describes how ss should collect data about their animals. T- we are going to setup the experiment. Be sure to be a team player. Each group will get an animal and you will have to measure the length. T suggests where to measure from tail to nose, elbow to elbow (monkey). Most ss listen to instructions while some students take notes. One group member needs to weigh the animal. One person per group should be prepared to determine length, height, or mass - record it on the sheet and then write it on the overhead. They have an electronic scale to measure the weight in grams. One student per group selected their animal from T's hand with eyes closed.	3A 4C 6B 7C 8C 10B 11C 13B 14B
	1		0:23	Ss work on the assignment/measurements in their groups and fill in data recording sheets. Each student fills in their own sheet individually. T - fill in the before column only today. She moves to each group to make sure they know which column to fill in with their measurements. T helps ss weigh their animal at the scale. Ss are all on task completing their roles. S - S ? What's mass? Do I wrap the ruler around it? I'm confused. One student in group takes the animal from confused student and takes it to the scale to weigh it. (Two ss curious about camera - I'll give you $2 to...).	15C
	1			(0:29) As groups finish their measurements, ss go to overhead and tell T and she writes the information on the overhead. T - tells class that they need to record the other groups info on their own recording sheets as well. Green gorilla, green lion, pink lion, and yellow lion Length, height, mass 30, 40, 2; 50, 25, 2; 42, 20, 2; 50, 47, 2 S-S? What are you writing, we don't have to write all of the others. Yes, we do. S-T Do we have to write the other groups. T- yes. (A little hard to read overhead.) S- S? Is that 2 or 3 grams for the gorilla? 0:35 T - raise your hand if you need another minute. A couple raise their hands. T stage whispers: Ok are you ready to move on, raise your pinky if you need more time. Some do raise it. T asks a s per group to check each other's papers and determine if they are about ready.	
	1		0:36	T reads "plop into water and watch it swell 5 times of the original size in less than 48 hours" S - 2 days. Ss each take one animal and put it in the tub in the middle of the room. S- T this is not rigid, it's... T helps him finish by saying flexible.	
	1		0:38	T- asks ss to complete a 3-2-1 (questions written on white board earlier) on the back of a piece of paper and when they turn it in they can go outside for recess. She points to the board that she had written the questions on earlier. Some ss look at vocabulary words or reading sheet as they complete their 3-2-1. All ss work quietly on their own. 0:40 (1st papers handed in.) 0:44 Only 2 girls are finishing up.	

	1		0:45	End of Tape.	
4/16/03	2	T1	0:00	On overhead, Growing Monsters (polymers) Ss are excited as they come in and see the bucket of monsters that have already started growing; T asks them to sit and asks some ss to go get others who are not in the room yet.	
	2	A1	0:01	Began with reviewing words and 3-2-1 responses (had 2 demonstrations). Asks ss to tell what the words mean and then T shows examples to ss. (polymers, plastic, resin, rigid, flexible). T - Where does resin come from? S- tree sap. T brought an example of tree sap with a bug in it (amber- passed an example around); compared to Jurassic Park. Talked about a different kind of tree sap, it's called a rubber tree. We get latex (has a bottle) from a rubber tree - she talks about the symbols/labels that are on the bottle for safety. (E.g. Health - 0 means that if you eat it, it won't harm you - but we aren't going to eat it.) And talks about scientists who order these types of chemicals. S- Will it go bad if you put it in a cabinet? T- it's not supposed to, but showed ss how the liquid had turned to a solid when she hadn't tightened the bottle enough. S - like latex gloves. T- right.	1B 2C 3A 4C 6C 7C 8B 10B 11C 15C
	2		0:05	Talked about 3-2-1 responses they gave yesterday and noticed that many of them noticed that they wanted to know more. I thought I would show you some other toys that are made from latex. Two latex demos. T stirred together latex and vinegar in a beaker (asks ss to tell what the beaker was). The mixture solidified and she took it out of the beaker and rolled it up into a ball. She showed how you could bounce it. T washes hands after demo. Demo 2 - Wacky wall walkers made by scientists. S- where'd you get it? T- I got it out of a magazine.	
	2	T2	0:11	T passes out National Geographic magazines and directs ss to page 12, an article of how gum is made from tree sap. She gives them some gum and they get to chew gum while they are reading. No bubbles or smacking!	
	2	A2	0:14	T reads page 12 to them. All ss reading along silently as she reads to them about how gum is made (old-fashioned way) - Chicle, jungle gum. Occasionally she asks them to say one of the words in the reading. T- What other story in social studies did we read where they took sap out of the tree? S - Laura Ingalls Wilder took it out of a different kind of tree. She talks about different colors - one student comment about different flavors like mint.	3A 7C 8B 10B 11C 13B 14B
	2		0:17	T - Instructs ss to read 13-16 and write 4 questions and answers that will be used on the test. S- Can we read with a partner? T- Yes, as long as you read quietly.	
	2		0:18	All ss read article. T sits with some groups as they read and circulates around room.	

				S-S? How far do we read? Ss work on questions as they are reading. T probe to s - What do you end an interrogative with? S - ooh a question mark. All ss reading and working well on the assignment, quiet and participating well. They each come up with their own questions. As ss finish early they look through the magazine. S-S ? Are you putting the answers with it? Yes. He goes back and writes his answers. One student asks the other 3 in his group to answer his questions w/out looking in their book.	
	2		0:32	T asks ss to tell interesting things that they learned from reading the article. They told her several things. They got bubble gum out of trees; Wrigley made the Juicy Fruit (that's why I gave you Juicy Fruit to chew); learned that it was made from sap. 300 pieces of gum per year (each person chews); 83 billion pieces of gum are chewed per year. T - What are some of the problems with gum the article pointed out? It gets stuck on clothes (put it in freezer and then take it off). T - Sometimes people litter, do you find it under seats in the bus. So if you want to chew gum, be responsible and throw it in the trash when you are finished.	
	2		0:36	Write your four questions with answers and when you are finished you put your head down so that I'll know that you are finished and I'll send you outside.	
	2		0:37	End of Tape. Most ss had completed the questions while they were reading. Only a couple had to finish.	
4/17	3*	A1	0:00	Vocabulary review - The ss reviewed vocabulary words for the lesson and went over what they had learned in the previous lesson.	7C 10B 11C
	3	A2	0:05	Animal data collection and discussion - The ss were given their data sheets from Day 1. They seemed very anxious to measure the animals. They had been watching them closely for the past few days. After each group was finished measuring and weighing the animals, the T went over the data.	4C 6B 11C 14B
	3		0:10	Each group gave their findings. Then T told them to multiply each number by five to see if it had grown five times its actual size. The ss came to the conclusion that the animals did not grow five times in height and length, but by weight. All three groups measured the beginning weight of their animals at 2 grams. The final weight was between 23 and 25 grams. The T gave each s an alien, another plastic water toy to take home to try the experiment again.	
	3	A3	0:25	The ss worked on a short webquest that gave information about polymers.	14B
	3	A4	0:45	To end the lesson, the ss discussed what they had learned and what they liked about the past three days. The teacher listened for verbal engagement for mastery.	7C 10B
	3		0:50	End of Class	
OVERALL COMINED LESSON CODES					5C 9C 12C 16C 17C 18C

	19B 20A 21B 22A

Room posters, etc.: Maps - world and continents, Happy B-day bulletin board, Time/money/weather chart/, math posters, word wall, Level I-III discipline, character counts posters, Metric system (t-made poster).

*Researcher unable to attend the third day of class and had the class videotaped. However, the tape was misplaced before it could be viewed so the classroom teacher wrote a synopsis of the activities. Several categories could not be evaluated for each activity.

A1: 1-4, 8, 13, 15; A2: 1-3, 13, 15; A3: 1-4, 13, 15; A4: 1-4, 13, 15

Appendix J.6 - STAM Record of Activities Post-Observations Daphne

Date	Tape	A or T	Start Time	Description	STAM Code
10/08/03	1	T1	0:00	T passes out science folders/journals to students as they are seated. K-W-L chart is posted in the front of the room. T asks ss to come sit in a circle in the front of the room with folder and pencil.	
	1	A1	0:03	We are going to extend what we were talking about yesterday. Open up your journals to look at your page from yesterday. How many of you drew a picture? (most raise hands). T passed around laminated pictures of the students she had taken yesterday as they were making observations. T took pictures of box of bugs (mealworms) so they could compare what they saw yesterday to what they see today. Before they look at the box the T introduced them to a K-W-L chart.	4C 7D 8D 10C 11D 20C
	1		0:04	T points to each letter and explains that K means What we know, W means what we want to learn, and L means what we learned. "We will fill out this graphic organizer as we work this week." Look through your notes from yesterday. What is one thing you know for a fact that's in this box? Cleveland - what's one thing. I saw something moving. T - What do you call it a bug? Jamaal? and others? S- oatmeal. T- that was bran. S- They were trying to find a comfortable place to stay. T- Did they look comfortable? Ss - yes (the ones under the thing) and no; they looked like they were sleeping. T- what did we place in the box? Ss - potato Teacher writes bugs are moving, bran in the box, and potatoes in the box.	
	1	T2	0:07	Let's go ahead and look at the box today. You need to open to a clean page and put the date, which is October 8th and then remember that word observation? S- yes. T- put observation 2. S-S (interaction) it's the 10th month and counts it out on her fingers. S- Ooh we get to touch them today. S - and hold them. S - October the what? T- October the 8th.	
	1	A2	0:08	T- carries box over to ss and sets it down in the center of their circle. The ss all scoot in to look at it. Ss - Ooooh. T- Ok now let's go ahead and draw what you see, make some observations. What do you see that is different from yesterday? S - that's a worm, that's a maggot. Ss are drawing in their journals and looking in the box. Some ooh's of disgust. S- that ain't no maggot, that's a worm. No,	1D 2D 4D 6D

				it's a caterpillar. S- I'm drawing what I saw. T- I'll give you about 5 minutes. T tells a student to label their sketch so she'll know what it is. T- What happened to the potatoes? S - I said that the potatoes are gone. S- no the potatoes aren't gone. T- well what happened to this one right here (pointing to picture from previous day). S- the white part got eaten. T- you need to write that down. Did you label? T points to sketch and says I need to know what that is. T- who needs a few more minutes (0:12)? Several indicate that they do. S looking at others pictures and says the potatoes are gone so why are you putting them in your pictures? S- can I read mine? T- what do think these are, maggots? (student had labeled his sketch with that). Do you think all of these are the same thing or do you think they are different? You see beetles and maggots. S- I think they are just a different size.	7D 8D 14D 15D 20C
	1	T3	0:13	Ss are asked to get back into the circle. S- can we work in a group of 4? T- You need to be very mature and very careful with these (magnifying glasses). She asks the students to pass the magnifying glasses around the circle so everyone can have one. One person was asked to share. S - can we work with 4? T- no, we are going to work in pairs. T scoops out some bran and mealworm mixture into pie pans for groups of students to observe closer. S- can we touch them? T- yes. S - asks if her group can move away from the circle some to work.	
	1	A3	0:16	T- Ok you need to take observations on what you see. Ss are all looking and using magnifying glasses to look closer. One s using it incorrectly and said she couldn't see anything. The T showed her how to hold it correctly. S-S look at this one. S - I picked one up. T- you need to draw and label what you see. S- there's one with a stinger (pupa). T - circulates to each pair and then says to group. "Ok this is what you need to be doing is to draw what you see. If you see a bug, draw it in detail, tell me how many legs, how many parts." S - look T, I wrote about what I saw. T - I want you to draw a picture too. S-S Did you touch one? yes. Don't scratch your head, you can get lice like that. T- no you can't. (Lots of partner discussion about what they are observing - very animated.) T- give yourself a plus 1 if you are following directions. Ss write a + 1 on their papers. T asks s to not put her hands in the bran because she was making a mess. T asks a couple of ss to erase their plus ones because they were talking to people that weren't in their pair at the moment. S - I see it breathing. T - Why do you think they like grapes? S - because they are worms and they like apples. T - what do you think that is? S- a caterpillar. T - do you think caterpillars like to live in bran? S- no T - you need to put these things in your notes. T asks another student pair about why they think the grapes are there. One S - for them to eat, for food. T- what do they like to eat? other S- potatoes. T- picks up a potato piece - what do you see? S- I see bite marks. T - you need to put that in your notes, do you think they will eat the grape? S- no. T moves to other group and looks closely at the things in the pan and asks the pair about what they	1D 2D 4D 6D 7D 8D 10C 14D 15D 20C

				are seeing. One students says ouch, it stung me. (the pupa stage). S - it has some sharp pieces to it. S picks it up. He thinks it's the same as the larva stage. Looks more closely and decides it's dead because it's not moving. T - Give yourself a plus one if you are working with your partner using a 6 inch voice and making observations.(0:28) S - I think it's a centipede. S- there are some babies in here. S - everybody thinks they're maggots but they're not. 0:33 T - 2 more minutes, so go ahead and write.	
	1	T4	0:34	On the count of ten put everything back in your pie plate, return your magnifying glass to the middle, and return to the circle. Each group can get a plus one if you do that.	
	1	A4	0:35	Raise your hand if you liked that. (They raised their hands.) T told them they could give themselves a plus one. I have a question for you. We are going to call them bugs for right now. How many different kinds of bugs did you see? Look through your notes. Ss - 3. Jasmine - 4, Cleveland - 4, no 5, Latrisia - 5, another -2. S (volunteer ?) - how come when I put mine up close it spread it's wings out and his didn't? T- so yours had wings. How many of you saw a caterpillar-like thing? What colors did you see? Ss - brown, yellow, white. T- How many of you saw something that looked like a beetle? Anashtin took some notes about that. How many legs did it have? S- 6. T- and you saw wings? S- yes and it had a pincher going like that. T- What else did you notice, what color was it? S- light brown. S - mine was kind of black. T - Ok looks like we took some good notes today. Does anyone else have something that they would like to share? Many raise their hands. T- Ok, let's go around the room and talk about it. T - asks each one to share. Ss - Caterpillar; I saw a caterpillar that looked like it was dead; I picked one up and put it on a potato; a cockroach; oatmeal, beetle juice, potato, and maggots; one of those little caterpillar things go inside that grape. T - why do you think it was going into the grape? S - that reminds me of the hungry caterpillar. Other comments: S - I saw one that looked like the caterpillar, curled up like a C; the potatoes were wet yesterday and today it's hard; they (potatoes) are dry and brown; a beetle	1D 2D 3D 4D 7D 8D 10C 11D 13C 15C 20C
	1	A5	0:41	We've been talking about food. Do you think that all of these bugs like grapes and potatoes? S- the one I saw liked grapes. T- Do you think they just like potatoes and grapes? S - no they like trash if they are maggots. T- hold on let's let Jasmine talk - don't step on Jasmine's voice. S- maggots turn into flies. T- Does anyone have any questions about what you saw? T writes their questions on the W part of the K-W-L chart (what we want to learn). S- How did the potato get like that after only one day (get brown, hard, and dissolve). What is the beetle-looking thing.T - do you think they like darkness or light? S - dark and light responses, if they get into light they turn into maggots, no they turn into flies. Give yourself a plus one if you are in criss-cross apple sauce position and participating. S (volunteer) - there was a beetle like thing on my porch - S? was it a flip-flop color? Yes. That was a june-bug. No it was a beetle. S - where did you get all of those bugs from? T-	1D 3D 4D 6D 7D 8D 10D 11D 13D 20D

				We'll talk about that later. Ok, I see 2 questions that we can make an experiment with. S- I see three. T - well, there's actually two that we can make an experiment with. Do they like light or dark and what do they like to eat? T takes a vote from class about what they would like to do - which one would you want to find out about. More students selected to test what they like to eat (7-5). T- by your observations we already know that they like grapes and potatoes. Let's think of 3 other things we could try to give them to see if they will eat it. Tell me one thing you'd like to try. S- banana, oranges, watermelon, apples, put some leaves up in there too. T - Let's narrow this down. Let's try leaves because that's different. T lets 2 students select among the others. They decide upon watermelon and bananas. Tomorrow we will set-up how we will do this. (3 ss lost 5 points, fidgety and talkative).	
	1	T5	0:51	Ss are given a stack of books on different animals and asked to take one. They are to return to their seats and take notes on the animal in their books.	
	1	A6	0:52	Ss look at pictures and share some interesting ones with each other. Most reading/looking through and writing notes.	1C 2C 20B
	1		0:59	End of tape - bathroom break.	
10/09/03	2	T1	0:00	Ss form a circle at the front of the room with their science folders. T asks to speak with one student outside of the classroom. On a clean sheet they are to put their name, date (today is the 9th) and you need to put observation 3. All students comply.	
	2	A1	0:02	T - reminds class of decision to determine what food the bugs like to eat. They had decided to test banana, watermelon, and leaves. T brought melon as a substitute for watermelon. Looking at the three choices, what are all of those? If an animal just ate those types of food, what type of animal are they? S- carnivores T - Now, what are carnivores? S - meat eaters. S - herbivores. T decided to add some meat to the types of food to give more choices. What kind of animal eats both meat and plants? S- omnivores. T- Maybe our question could be - Are our bugs herbivores, carnivores, or omnivores? S - what is the essential question of the day? T - T repeats the question. T- distributes handout to students to organize the experiment. Scientists always have to plan out what they are going to do in an experiment. T - writes "Are the bugs carnivores, herbivores, or omnivores?" on a large pad of paper on an easel and asks the ss to copy it. T- And what do we do with a question sentence? S - put a question mark. T - And what do we call a question mark sentence? S - interrogative. T - good. If you have this sentence on your paper and began with a capital letter and ended in a question mark, you may give yourself a plus one. Several ss correct their papers. After a scientist determines their question, they need to make a prediction of what they think is going to happen and that is called a hypothesis. So, do you think the bugs are carnivores, herbivores, or omnivores? S - carnivores. T- and that means what? S - that they eat meat. T asks	1D 2C 3D 4D 6D 7C/D 8C/D 10C 11D 13D 15C 20D

				for a raise of hands for their guess for each type. That is your hypothesis. She writes, "I predict (we've had that word in reading) that the bugs are _____." S -What did you call it again when they just eat plants? T - Hervivores. T asked a student to be careful to not get into another s's personal space. Teacher puts a star next to the word hypothesis as a reminder to put it on the word wall and talk about it more later. 0:12 Moves on to procedure section. T- asks S, What do you think procedures are? S- steps. T - steps, steps that you follow, good. S - what does K-W-L stand for? T- We'll talk about that later. T shows the students the materials available - pie pans, melons, bananas, meat (turkey), and leaves, bugs. How do you think we will set this up? Remember that we talked about reading sequencing and putting things in order. How are we going to put this experiment in order? If you have an idea raise your hand. S - put the bananas and melons first. some ss disagree. T- does anyone else have an idea of what we should do first? How will we place the pie plate? One student suggested putting all of the food around the edges of the pie plate and then putting the bugs in the middle to see where they would go. T - Ok, great do you want to try that today. Ss - all yes. T - then let's setup our procedures. T writes materials on chart for #1: pie plate, melon, turkey, banana, and leaves. She asks the ss to write this on their papers. #2 Place pie plate on floor. Remember we had a little accident yesterday so you need to keep it on the floor. T - after we put the pie plate on the floor what are we going to do? S - put the oatmeal in. S - we don't have oatmeal. S - put the bugs in. T - we don't want the bugs in first. Ss - we should put the food in. #3 Place foods on the edge of pie plate. #4 Place bugs in the middle of the pie plate. T -Why don't we put the bugs around the edge? S - because they would walk around and crawl out. T - How long do you think we should observe? S- 16 minutes; 1 hour and 30 minutes, 30 minutes. T - Ok, how about we go for about 20 minutes. #5 Observe for 20 minutes.	
	2	T2	0:22	If you have everything on your sheet completed put a plus one on your paper. Class divided into two groups (6 in each group). Students count off 1 -2 -1 -2 they hold 1 or 2 fingers in the air to show their group. Ss are asked to sit in a circle with their group. T gives a pie plate to each group. T places food on a serving tray and takes it to each group for them to place in their pie plate. T - reminds groups to work as a team. Suggests to one group to tear up their leaves. Ss each take a leaf and rip it apart. When students have arranged their food, T brings 5 mealworms and 1 beetle to put in the middle.	
	2	A2	0:25	Ss watch the bugs to see where they go. 0:29 some ss in one group began to put the mealworms on the food. T - you cannot touch the bug because that messes up the experiment. 0:31T - reminds ss to draw and write about what they are seeing in their journals. S - observed one bug was not moving and decided it was dead. T - reminded them to label what they were drawing. One group - 2 bugs in middle, 2 under leaf, 1 beetle under leaf, and one bug on the turkey. S tried to move a leaf	1D 2D 3D 4D 6D 7D 14D 20D

				to expose the beetle. Other ss told him not to. S - I told you they liked the dark.	
	2	T3	0:37	Let's go ahead and form one circle. Leave pie plate where you were working. We need to talk about what we've seen up to this point and check our predictions and give them some more time to decide what they would like to eat.	
	2	A3	0:38	Let's discuss about working in our teams today. You were doing a great job. Let's talk about some of the ways that I can evaluate you today. T - what shows a good team member? T writes their responses on the K-W-L chart. S - working together without fighting; taking turns. T - did you respect each other when people were talking? T adds respectful to the list. S - adds not being bossy. T - Focusing, looking, and listening to the list. T - look at this list and write down in your journal under your observations how you were a good team member today. T gives them 2-3 minutes. T - what you write will help me grade your work today.	1D 7D 8D 10C 11D 14D 20D
	2	A4	0:45	T asks one s to describe what is happening in one of the plates. S - the beetle is eating the leaves. (other inaudible) - one was on the meat. T - On your sheet write down what happened in your experiment. What are your bugs eating right now. One group - 2 bugs did not move and the other 3 are under the leaves. T - It seems like in both groups the bugs decided to eat the leaves. So how does that compare to your predictions. Ss share some of their predictions. Conclusion - The bugs like to eat the leaves, so they are what? Ss respond herbivores, carnivores, and omnivores. T - lets them know it should be herbivores.	1D 3C 4D 7D 8D 11C 15C
	2	T4	0:51	Spend two minutes finishing filling out your paper and when you are finished, you may go to your seat.	
	2		0:52	End of tape	
10/10/03	3	T1	0:00	T asks ss to sit in a circle with science folders	
	3	A1	0:02	Discuss previous days experiments. What did we find out about the bugs? S- What they like to eat. T- did we find out that they were herbivores, carnivores, and omnivores? Ss respond with mostly herbivores. T reviews the meaning of each word with ss. T asks ss. S- an animal that eats ...? S - she said animal, it should be an insect. T - an insect is an animal. S - uh uh, animals are big. T moves on.	1C 2C 3C 4C 7C 8C 10B 11C 13C 15D 20B
	3	T2	0:04	Open journal to a clean page, put the date and your name. T - today is Oct. 10th.	
	3	A2	0:06	T directs ss attention to the K-W-L chart. Under the L column, T writes some things that the ss learned. Bugs liked to eat plants. T- you are going to find out the answer to many of your other questions with our internet activity today.	1B 2C 3C
	3		0:08	These bugs are called... T holds up a book titled Mealworms and the ss say mealworms. She discusses the front cover of the book and the different stages (4) of the mealworm and said that the stages were part of a life cycle. Like in the 3rd grade when you talked about the stages of a frog's	4C 7C 8C

				life cycle. T reads book for ss which discusses how to maintain a mealworm farm, and describes mealworms as insects. T- so what are mealworms? Ss - insects. T - four stages, egg, larva, pupa, to adult. The change is called metamorphosis. T - how many of you saw the egg. Several ss said they did. T- book said the eggs were too small to see without a microscope. Ss referred to the stages that they drew in their observation book. T -beetle lays up to 500 eggs and dies soon after. 0:13 - phone call.	20B
	3	T3	0:14	T describes webquest that she has created for ss about mealworms. T - Try to get the address on the computer at least twice before you ask for help - alot of times you give up after one try. (8 computers and 1 laptop.) S - T do we have to do the back? T - yes.	
	3	A3	0:15	Ss work on the computers individually (7) or in pairs (2) to answer the questions. One pair of individual students are close enough to work together. T circulates to help ss access the site and find their answers. Worksheet: Website - http://insected.arl.arizona.edu/mealinfo.htm Draw a picture of the mealworm as a Larva and an adult beetle; Write 3 characteristics of an adult beetle; What do mealworms like to eat?; Where do mealworms live?; What animals like to eat mealworms?; Do mealworms prefer darkness or light?; Where can you get mealworms? 3-2-1 Write three things you learned, Write two things you liked about working with mealworms; Write one way you were a great team player. S - T it doesn't say if they like dark or light or what likes to eat them. T - actually I gave some mealworms to a s that has a lizard to eat them. T - the answers are on this page somewhere, keep looking. S - It doesn't say what likes to eat mealworms, It just says predators. T - What are predators? Read the sentence again. S - reads it again and decides that the predators they list eat the mealworms. 0:36 2 male ss had only completed the pictures on the larva and beetle and had not started on the rest of the worksheet. One girl s working on 3 things she learned. A boy s said she learned to be bad. Girl complained to T. T corrected boy - told to not speak to her.	1C 2C 3C 4C 6C 7C 8C 10B 13C 14C 20B
	3	T4	0:47	Ss are asked to return to the circle in the front of the room to wrap up the activity even if they weren't finished.	
	3	A4	0:48	Ss share one thing that they learned from the website activity today. Mealworms eat leaves, sticks, and fruits; T - how many stages are there? S - 4; The predators are lizards, spiders, and birds. T - We had a little trouble with that word. That's when something eats something else. S - and bears. T - did you find that on the website? S - no. S - they live under	1C 3C 4C 10B

				rocks; you can buy mealworms very cheap; they live under rocks and logs; T - do they prefer darkness or light? S - dark; a s showed her pictures to the class and pointed out the larva and the adult beetle.	11C 15C 20C
	3		0:52	Monday, class will get in groups and they will do concept maps about what they learned and create a Power Point. They will be able to use the digital pictures the T took in class in their presentation.	
	3	A5	0:53	Write a quick paragraph about another experiment that you would like to try with mealworms on the page in your journal that you wrote your name and date on. Take about 2-3 minutes. Students working quietly on this.	10D 11D 20C
	3		0:58	End of tape	
OVERALL COMBINED LESSON CODES					5D 9D 12D/E 16C/E 17D 18D 19C 21B 22A

Teacher-made Posters - Things we've read together, word wall, how to understand the author's message, some ways to talk about your book, Classroom managers bulletin board, book genres
Posters - math set (polygons, triangles, geometric shapes, and angles), multiplication chart, character counts posters, geography - world maps.
Teacher took digital pictures daily.

Appendix J.7 - STAM Record of Activities Pre Observations Shannon

Date	Tape	A or T	Start Time	Description	STAM Code
4/17/03	1	A1	0:00	Review of yesterday's lesson with Mr. Bones. Names of bones vertebrae, cranium (skull - helps protect the brain), uses stories to help ss be able to remember the names, part of the body that helps with shoulder movement, thin, smaller bone - S- clavicle, T- and what's the common name for it? S- collar bone Larger bone in the hip area, allows you to dance, move, and walk rhymes with Elvis. Largest bone in the body? S- femur, T- where is that on your body, stand up and show me. S- demonstrates. Longest bone in the body, connecting to the funny bone - it's very, very funny, humerus. Radius, ulna (upper and lower), phalanges, carpals (refers to syndrome) and tarsals. I've probably missed some. (0:07) What would we be like w/out bones? Raise your hand to speak. S - like a puddle or a blob.	1C 2C 7C 8C 10B 11C 13A 14A 15A 17B 18C
	1	A2	0:08	Ss present letters to The Body Corporation. T - Let me give you your time to tell me what you know about bones. Let's review the four requirements of your writing assignment. (overhead) The Body Corporation (TBC) Dear TBC member: 1. Tell the name of bone 2. Tell the names of other employees with whom you work and how you work together. 3. Describe your main function 4. Tell TBC why you are important to him and why they should not fire (If you fire me....) Add picture (not required) 1 page double spaced written	1D 2D 7C 10B 13A 14B 15C 17B 18C
	1		0:10	T - Who would like to present today? About 5-6 raise their hands. We need to encourage each other and for each presentation be prepared to give two compliments. One student at a time stands in the front of the room and reads his/her paper to the class. All ss listen. Presentation on femur. T summarizes what the student presented and asks for two compliments from the class. I like the way he said the words. - used casual but used scientific too. One wrote his paper as a mystery. The class had to determine which bone he described. Many ss raised hands and were able to answer - scapula. (The student had suggested creating the mystery story and T incorporated that into the assignment possibilities.) Compliments: Very descriptive, nice creativity.	

				Other presentations, Clavicle, cranium, Skull, Pelvis (2), Any others. T - Very nice work - most of you followed all of the requirements.	
	1	T1	0:24	We are going to do another activity and I may need to move a couple of you to other groups; Turn books to page G-16 - Tired muscles activity. On Overhead *60 seconds =* *Right hand trial 1-3 Left hand trial 1-3*	
	1	A3	0:26	How many of you have played so much that you were absolutely exhausted. T asked several ss about their activities after school -Trampoline, scooter, skateboard, basketball (Afternoon activities), football (arms and legs get tired) T- what part of your body tires first? Body changes over time - you have alot of energy now.	1C 2C 3C 4C 7D
	1		0:28	T describes muscle activity. Working in pairs - Procedures in blue on page G-16 (1-4). Gives each group a clip. You will need a piece of paper per group to record information. She confirms that they can determine a minute with the wall clock. Count the number of times you can open and close fully the spring clip in 60 seconds. Use the right hand first as the instructions say and complete 3 trials. Wait 60 seconds between hands. (0:31) Let's predict for a moment. How many times do you think you can open and close this in 60 seconds. Several guessed between 50-60; and one said 16-17. What did you use to base your estimate on? Are any of you using the time? Some of you might be saying that you might be able to get one per second. The low estimate - didn't want to overestimate and not make it. If you get a different clip from someone else, don't worry about it, we'll talk about it. Groups of two - some are groups of three. You will need to record info on your paper.	8D 11C 13A 14B 15B 17B 18D
	1		0:34	We will spend about 10 minutes on this activity. You may begin. Very good - already have their paper ready. S - I beat my estimate (66). Some are getting 180 - 220. T- please don't come and tell me the numbers, I'll forget them. Write them down, that's the point. If you've made it through 2 trials on one hand go ahead and move to the other hand. All ss participate in activity. 0:41 T- Make sure that you have made it through at least 2 trials on one hand and move on to the other hand. The S with the tough clip asked a student from one of the other groups to try his, since it was so much harder.	

	1		0:46	OK put the clips down please. What did we think about this activity so far? S - It's fun; T- Why? S- it makes your fingers get really tired. I think you should do it with your next year's class because I think they'll like it. T - Well let's see what we learned from it. Let's get some trial results. Right hand: 110, 118 118, 105, 100 111, 180 (got used to it the second time) Left hand: 176, 130, 111 121, 149, 129 1, 33 T- Three samples of data - what do we notice about this data?	
	1		0:51	Discussion of data. T- Our results are a little different, but that's OK. Did anyone else notice like with the trampoline your hand got tired after time? The left hand had a higher # than right and that's kind of surprising. Why would the # of times decrease each time (from high to low to low)? S - they get tired. T- Are you using muscles to do this? Do you think that if we did 30 trials you would be able to do the same? Ss- No. T- Why would I think that we would do more with the right than left hand? S- Because nobody uses their left hand that much. T- they fatigue, or tire faster. T- If ___ were here which one of her hands do you think could handle more (she's left-handed). How many got similar to what you predicted? She gave 1 middle size clip (hardest to squeeze) and 1 large clip; all the rest had the smallest clips. Largest was easiest	
	1	T2	0:58	Are there any questions about what we learned today? No T - Tell me what you learned? S- It was fun and it makes you want to go to sleep; It makes your muscles tired. S - Why do your muscles get tired? T - Good question, that happens when you use them. Phone rings 0:59	
	1		1:00	End of Tape. Class ends - bathroom break; stories need to be passed in.	
4/24/03	2	T1	0:00	Ss are asked to open Science books to G28. We've learned about the skeleton, muscles, joints and movement. What we're going to learn about today is about nerves and impulses - nervous system	
	2	A1	0:01	Throwing ball demonstration. T - What are we seeing here when I'm throwing the ball and you are catching it? One student commented that they used kinetic energy. T- summed that she noticed the body parts used to catch the ball. S - they reacted and caught the ball even when the T did not make eye contact. (Go-around cup used to call on ss) T- Oh good word *reaction*. T threw ball back and forth to student and discussed eye-hand coordination and their reaction. If the ball is thrown and someone is not	1C 2C 4C 7C 8C 13A 14A 15C 17B 18C

				expecting it their reaction is not as fast.	
	2	T2	0:06	T describes Meter stick/reaction time demonstration. She used the go around cup to choose a helper- they completed a few trials with the meter stick reaction time. T asks ss to predict where they think the T will be able to grab the yardstick. Ss predicted 20, 23, and 18 inches.	
	2	A2	0:09	Conducted Meter stick/reaction time demonstration Actual catches: 14, 15, 10, 9, 7, 8, 11. Trials 1-4 with one student and then used a second student for trial 4-7. T - What do you notice about trials 3-7? S- 1st trial was high and then it got lower. T- How many of you agree (all ss raise their hands) T- how does this compare to our predictions? S brought up that T could move forward or back and might not have started at the same spot. T- that's a good point, the experiment was not extremely accurate. What are you thinking? (twice). S responded and T said that's where I'm going with this - good! After several trials, I knew what to expect.	1C 2C 3C 4C 7C 8D 11C 13A 14A 15C 17B 18C
	2	T3	0:18	You already have your book open to G-28. We are going to make our vocabulary books today. T- passes out a sheet of paper to each student.	
	2	A3	0:19	Ss make a vocabulary notebook and use it for notes. T demos a hamburger fold (*Dinah Zike* fold). T - good lots of people following instructions. After hamburger, fold hotdog. Narrow skinny, press creases while waiting. Now brownie - these brownies have what kind of insects in them. S - cockroaches, grasshoppers OR nuts. T - Now unfold to skinny hot dog and hamburger - frog mouth fold toward tummy - middle point toward back of tongue and cut it and open as a V- No scissors, tape, staples, of mine yet, we will pass them out at the end. (0:23) On the front cover put your name, subject, today's date, and topic (the nervous system) - T wrote this on overhead as she said it. If anybody has trouble you can have my book. Those of you managing absences you can make theirs in your extra time. One s could not get his folds; another s tried to help - a girl told her you just make things worse. T gave her book to the boy.	1C 2C 3A 4B 7C 8C 13B 14B 15B 17B 18D
	2		0:25	T reads textbook to ss. Please follow along (as she reads) about reaction time. T - On page 1 write nerve impulse. S should we make it take up the whole sheet? T - No you will have several words on this page, write it small. T reads textbook and writes term and definition on overhead and asks the ss to write it. T - Who carries that message? Ss - We do. T - your nerve cells. *Nerve impulse* **-** *message carried through the body by nerve cells* *Neuron* (draw a little envelope so you will remember that it's a message) S - Should we write this on the next page? T - just like I have it on my sheet.	

				Neuron **-** *Nerve cell* (draw a person w/a bag thrown over shoulder). T - talked w/ss about how they respond to having hair pulled for example. Two types of nerve cells (drew arrows and said this is exactly how it should look on your page) - *sensory neurons* (senses, like sounds) or *motor (muscles, big movements) neuron*. (T- gives examples as they are introduced) We will write one more on this page - if it doesn't fit, we'll flip to the next. Let's talk about what we know now - teacher recaps the words they have written. Next page is one fact - I'm putting a star by that one because it's pretty interesting. What happens between a stimulus and a response? What was the stimulus when I threw the ball and you caught it? S - what is a stimulus? T- Something that starts the reaction and causes the neurons to send a message. S- throwing the ball. T - compares to the ball demo at the beginning of the class. Neurons are like electricity. Can you think about how fast they move. Ss - Yes - we saw it yesterday at the discovery center. Here's our quick fact: * *A nerve impulse can travel* (through your nervous system) *at speeds* (now this is really neat*) of 10 to 120 miles per second.* Ss interested. T - This is happening so fast- it is sending out mail so fast.	
	2	T4	0:39	Ok this is what I want you to do with what you know. (We are going to take a tour of the brain tomorrow). Look at G29 - You can use your book or a larger piece of paper - it's your choice. You need to read page G29 - the book has it in the books words. You need to read those, get it in your mind, and then put it in your own words - like our reading skill paraphrasing.	
	2	A4	0:41	T describes the assignment of listing the steps of a stimulus. T - Some of you are up and I'm not finished yet. List the steps that it takes for me to catch that meterstick (yardstick). How many boxes do you see? S- 3 T- 5. How many steps do you think you should have? 5. Are you going to copy? S- no. T- you are going to paraphrase. I would suggest that you draw a picture. You can use arrows to describe what is happening. Option A is pictures and steps. Option B is a paragraph. S - what's option C. T - there is no option C. Questions about the assignment or about nerve impulses? S - about the assignment, clarifying. Other ss - May I have a large piece of paper, me too(s). T allows s to pass out some to those who want it. One s said she would have felt guilty if she had hit T with yardstick. T- that would have been OK because I told you to do it. A s writes the assignment on the assignment chart without being prompted by teacher.	1D 2D 4B 10B 13B 14C 17B 18D
	2		0:47	Ss work on assignment. S-T Can I work with a partner? T- Do you think you need a partner to put it in your own words? You can try it. Ss (majority) are spending time working on assignment.	
	2		0:50	End of Tape. Ss continue to work for several minutes before they switch to spelling.	

4/29/03	3	T1	0:00	Testing Reactions activity (3 questions) - take out homework and we will discuss those. RECESS written on board (T erases an S for behavior in hall). I'll wait and you will too. Ss get quiet. Turn to page G-36 in textbooks.	
	3	A1	0:02	T reviews bones, joints, and reflexes. Test Thursday instead of Friday, rearranging schedule. T - Be sure to write this down if you are managing absences. Tell me something that we've learned so far in this unit. S- bones. T- What did you learn about them? S - their names. T- what do they do for your body? S- they help you move. T- what are other things? S - they help you stand up straight. (some ss stand up to move and T tells them that's rude because she is talking). S- cerebrum. T- what does that do for us? S- it's the largest part of the brain. T- it controls the attitude, what else does it control? S- it controls sensory-motor, arms, hands. Like the light bulb. T- it also controls your feeling. T- we also have the cerebellum. S- it controls your neck. T- it is in your neck, turn back in your book to see what it says if you don't remember, it's right here on page G-32. She used the go-around cup to call on someone. She told them where on the page to look and asked them to paraphrase. S- gives you the sense of balance. T - We have joint types. Who can remember one type? S- ball and socket. T puts a transparency (not visible on tape) on overhead with picture. Who can tell me another part of the body that has this type of joint besides the shoulder. S- hip (out of turn). T- another s said the hinge joint is another type - open and close, one direction or the other. T- An example is the knee and your elbow. T- another type of joint (there is a list of joints on overhead now). S- pivot. T- example is the neck, one part of the bone stays stable and the other part moves. S- comments that an owl is different. T- and a gliding joint, this is where one joint glides over the other. This is in the ankle and wrist. S - Wouldn't the ankle be a ball and socket joint? T- you can feel the bone part which feels like a ball, but it's the end of the bone - she draws a picture on the overhead for the ss to see. 0:14 We will use the lap-top computers where you put the skeleton together and practice but not-today. Review bones created on your Mr. Bones activity. T points to body part and ss call out name of bone. Ss say names and T gives more details about what it's used for and other qualifying characteristics. E.g. Covers and protects the heart? Ss rib cage. It creates the spine? Ss vertebrae. Yesterday you all did some experimenting with the patella area. S - Which is the radius and which is the ulna and which is the tibia and which is the fibula? T has overhead picture of bones as visual.	1C 2C 3B 4B/C 7C 8C 10B 11C 13B 14A 15C 17A 18C
	3		0:17	3 questions from yesterday (Reflex activity - involuntary and voluntary reactions). (Did the substitute yesterday explain?) Compares to UT vols - we are volunteers because we volunteer, we don't get paid, somebody who does something to help out, you do because you choose to and want to. T- If I ask you to lift your right leg or pat your head. Ss - do this and T tells them this is voluntary because they chose to do it.	

				Opposite of voluntary - involuntary, you don't have control over it, it just happens. E.g how many of your parents have a white car; blinking, heart beat, breathing. T- are you with me? Some of you aren't. Go-around cup was used.	
	3	A2	0:22	Teacher reads a section from book to ss about the 5 senses. T reads page G-27 to ss and asks questions as she is reading. T- Which system has to do with senses? S called upon was not able to answer. T- points out times when ss have used senses. S had said earlier today that she smelled pizza for lunch. T asks ss if they have experienced walking into their house and smelling food and they know what it is (their favorite). T writes senses on overhead - touch (your skin is your body's largest organ reading from book). Apply pressure to your arm. Second sense - Taste. Stick out your tongue and look down. Do you see any white spots? - Those are your sensory receptors. Expands a bit on the book - your receptors helped you determine if you are enjoying lasagna, etc.; _____ has a book with some pictures that will show more of this called the Nervous system and the brain (you can look at it later). Example of when you have a cold - things taste different. Sense 3 - Smell - what's the biggest thing that helps you smell? You have hairs in your nose but they are there as filters. Then reads about receptors in nose. Your receptors sense if something smells good or smelly - they don't really talk but they say shoo that smells bad or that smells good. Sense 4 - Sight; Our receptors help us be able to recognize each other, colors, things. T- your brain is what really sees it just happens through your eyes. If you really want to talk scientifically you say that you see and smell with your brain. Your nose and eyes are the receptors. That's why things are so damaged if your brain is hurt. Sense 5 - Hearing. Reads about inner ear connecting to balance and T compares that to cerebellum which also is connected to balance.	1C 2C/D 3A 4B 7C 8C 11C 13D 14A 15C 17A 18C
	3		0:38	T asks the class if they have any questions. S - If person dies, and the brain still works, and you put the brain in another person's body, what would happen? T- If they connected it correctly, they would probably have the same personality as the original person with the brain. But that is not possible. They do things in movies but they don't really happen in actuality. S - If you touch something hot, does the heat itself travel through your arm and burn you? T- Good question, no. You are really thinking. The heat doesn't travel though your body, your receptors sense it and send a message. The same thing happens with your sense of smell. S- How come you smell something in your nose and then taste it in your mouth? T- because your senses are connected. Smell and taste are connected; hearing and seeing are connected. T gives them some examples of this. T- How many of you have eaten something and gotten sick and then	

				the next time you don't like it or want it? Ss say they have. T gives an example of a time that happened to her and the association between eating and becoming sick. S - talks about nosebleed (inaudible) T- talks about nosebleeds. When you get hot sometimes you get nosebleeds. Your blood clots, that means it gets thick. S - talks about how mouth waters when he thinks of something that tastes good to him.	
	3		0:51	End of Tape. No time for Senses activity. Tomorrow they will be talking about the stages of human mental development. Class ends and T assigns spelling work.	
OVERALL COMBINED LESSON CODES					5C 6C9C 12C 16C 19B 20A 21B 22A

(she has a few other diagrams of bones on her desk as visuals).
Materials/environment: Encyclopedias, Class Manger bulletin board, Reading vocabulary chart, 4 computers, Homework bulletin B.

Appendix J.8 - STAM Record of Activities Post-Observations Shannon

Date	Tape	A or T	Start Time	Description	STAM Code
11/6/03	1	T1	0:00	T asks ss to remove their reading assignments from their desks and finish up their snacks. Open science book to page F-22. S- Do we need to have our work out? T- Go ahead and get out your spectrum sheet from Monday.	
	1	A1	0:01	T asks ss questions as review of what they did in class on Monday. T -When we all grouped together, we had a certain kind of light. What was it, what did we learn about the spectrum? (used go-around cup) S - We had a purple light. T - What did we call it specifically? S - A black light. T - Like when we had the light off in the room; and even yesterday on our field trip when we went into the space shuttle (model) there was a black light. You could see our teeth glowing. The black light it does something different. Brighter colors, fluorescents glow (referred to a s's shorts. Did anyone find out where they fell on the spectrum? S - UV rays T - Right, ultraviolet rays. What did we say about UV rays? S - (different) You can't see the rays. T- You have to look at it differently or you won't see it. Like most of you did not realize that a	1C 2C 3C 4C 7C 8C 10B 11C 13C

				microwave was the way something travels, not just a black box in your kitchen.	
	1	A2	0:04	T gave ss an organization sheet for taking notes. She wrote reflection and refraction on the overhead and asked ss what they already knew about these words. S- Both of them have the letters "re" in them and that means to do it again. T- Good you are talking about the prefixes. That's a good thing you spotted. Any other things? S- Those mirrors that we saw yesterday on the field trip that made us tall and skinny or short and fat. T- Right, I wish we could bring those here. I do have smaller versions of those for us to use today. How many of you saw the curved mirror yesterday that made you look really tall? (raised hands) How many saw the mirror that curved inward that made you look small? (raised hands). Teacher points out three other words they will look at today, plane, concave, and convex. Did anyone else remember anything about the word reflection? I know you've heard that word before. S- Like when you asked about what we do during the day, we write a reflection. T - Good that's a different kind of reflection.	1C 2C 3C 4C 7C 8C 11C 13C 15C
	1		0:08	Let's look at F-22 in our book. T reads some sections from the book. Reflection is the light bouncing back. How many of you look in the mirror before you come to school in the morning? (raised hands). Let's write that down reflection is the light bouncing back.	
	1		0:09	T selects a helper and demonstrates how light travels in waves using a *Slinky*. Not ocean waves, there's not water traveling. Light travels kind of like a roller coaster, a loopedy loop. T and S hold slinky stretched out across the front of the room and demonstrate how waves move like the movement of the *Slinky*. (0:13 end demo) T - Everyone look up at the lights, do you all see the slinkies coming down? Ss - no. T - Imagine that the light moves light slinkies from the ceiling? What about from the sun? Ss - yes, it moves the same way. T - that's how it's able to bounce back. Like when it hits a mirror, the light is able to bounce back as part of the wave and you will be able to see yourself. And this other word refraction, I'm not going to read to you everything that it says, but it means the bending of light. Write that in your notes. Now we know, how does light travel? Light travels in... Ss - waves. T- Write that down and put like *Slinky, Jr*. in parenthesis.	
	1	A3	0:16	We are going to work in groups of 3 and I will give you some materials soon to work with. Look at F-20 (experiment page) - we will do a slightly different experiment than what you see here. You will get a mirror, a flashlight (T demos how to turn it on and off), aluminum foil (please don't fold it up), a couple of different types of mirrors (concave and convex - but she didn't tell them which one was which).	1D 2D 3C 4D 7D 8D 10B 13C 14D
	1	T2	0:19	T asks ss to work on desks not the floor. Gives ss a chance to clear off desk.	
	1	A3 cont.	0:20	T - Goals for your group work. See if you can show reflection and refraction. See if you can figure	

				out which of the items in your bag fit into the different types of mirrors. The flashlight is to help you produce refraction, that's the bending of light. You need to use the mirrors and light to try to reflect and refract them on the black construction paper (trifold). Try to figure out the meaning of these 5 words and how to show it. S - will it tell you how in the book? T - No, you guys are better than that, you can figure it out. Use your paper to draw a sketch and describe how you did it. I expect that each group will do these in different creative ways. What are our goals? S - To get the mirrors to reflect. T - Mirrors to refract and the meaning of these three words. What else are you going to do? S - Draw a sketch. T- Anything else? S - Try to figure out more than one way; work hard. T - And show creativity. How do we work in our groups? S- Everyone participates, shares, give each person a turn. T - questions before we start? S question about how they will be grouped.	
	1	T3	0:24	T asks ss to work with the ss who are sitting next to each other (2-3). They are told they can start when they get their materials (teacher passes them out)	
	1	A3 cont.	0:25	Ss - take materials out of bags and start looking at what they have. (5 groups - 3-4; 2-2) 0:26 - lights are turned off. All groups attempting to use the different materials in different combinations to reflect on the black construction paper. T circulates to see what the ss are doing and asks a couple of ss to participate with their groups (they worked well after being asked to). Ss show T some discoveries. T - I see, so you think the light is traveling, how do you think the light is traveling? S - back and forth. T- What are those new words we are calling it - the bouncing and the bending? S - refraction and reflection. T- How is it traveling, like Slinky, Jr.? S - through waves. T- Good - record that and try something new.	
	1		0:31	T with a new group. Trying to help them understand the terms reflection and refraction in terms of what they are experiencing with the lights and mirrors. T - let me show you another example of refraction. Does that make sense? Ss - a little bit. T - play around with it a little bit more and see what you can come up with.	
	1		0:34	T with a group. T suggests that they hold their mirrors closer to what they are trying to reflect it upon. Ss had been holding them several feet back and the mirrors were to small to have a great distance.	
	1		0:36	T continues circulating among groups. All are on task and using the flashlight and mirrors in as many ways as they can think of. Most are gathering and recording data on their note paper.	

				0:39 - T suggests to same group as previously that they use the mirror and flashlight closer to the object which they are trying to reflect upon.	
	1		0:42	TAG ss (5) returning to class and T gives them materials to collect as much data as they have time to.	
	1	T4	0:44	T asks a s to turn lights back on. T raises hand for ss attention. T asks the s with the first letter of their first name closest to "A" to collect the materials in the plastic bag and return them to the T. The rest of the group is asked to remain seated.	
	1	A4	0:47	Closure - Let's talk about what we learned. T used Go-Around cup. T- S what did you find out about one of these 5 words (from handout). S - inaudible T - How many mirrors did you put together at once? S - all of them. T - How many groups used all of the mirrors at once (several raised hands)? How many used just one mirror the whole time (no one)? How many used 2-3 items at once (most raised)? T- What's the new word that we use to describe when we look at ourselves in the mirror? Ss - reflection. T - Some of you might have already drawn a picture but if you haven't draw a stick figure standing in front of a mirror and draw arrows to show the light waves bouncing back to create the reflection. T- what did the aluminum foil do? S - If you shine the light on the foil it reflected all over. T - Since the crumpled foil has all of these bumps in it, it causes the light to bend and refract. Shows the plane mirror and contrasts how smooth it is. Draw a picture of the aluminum foil and draw arrows to show how the light was bending out from it. T holds up three mirrors from the bag and asks which they think is the plane one. This one curves out like the lens on glasses, this one curves in, and this one is flat. Most felt that the flat one was the plane mirror. T tells them they were correct and asks them to draw a rectangle to represent the mirror and write "flat surface". T directs them to pictures of concave and convex mirrors in the book. She holds up the other mirrors and they select the concave and convex mirrors correctly and draw sketches on their sheets. T - How many of you looked in the concave mirror yourself? What happened? S- you're upside down. T- the reflection is flipped because it's caving inward. S - you can remember what concave means because of the "cave" in the word. T - Good point. Concave mirrors are used on cars for reflectors, for solar rays in a solar oven (examples from book). When you looked at the concave mirror on the field trip you looked really short - everything caved in. When you looked in the convex mirror you looked really tall and the part in the middle looked nice and long. Do you think your reflection will be distorted when you look in a plane mirror? Ss- shake heads no. T- any questions about today or the 5 words? S - why did the concave mirror make things look upside down? T - because it caves in and the reflected light flips.	1C 2C 3C 4C 7C 8D 10B 13C 15C

				S - I watched a show that had an angel that looked in a mirror. T - so they were reflecting using mirrors. S- I think the concave and convex mirrors were interesting.	
	1		0:59	T gave compliments on the groups that worked well and asked them to save their sheets until the next day. End of Tape	
11/7/03	2	A1	0:00	Ss are finishing snack time. Oral warmup/review - How does light travel? Most raise hands S - by rays and waves. Other ss say waves. S - waves that are reflected. T - light waves, not ocean waves, like *Slinky, Jr*. T uses slinky as she is discussing this. T - What are some things that you remember from yesterday? S - concave. T - what do you remember about that word? S - It's a light that's pushed in. T - It's a mirror or a lens that is pushed in or caved in. It almost looked like a moon when we put it in our notes yesterday. T describes and sketches on overhead how the concave mirror distorts images. What's another word we talked about yesterday? S - convex. T describes the convex mirror and then talks about the plane mirror, reflection and refraction. Tell me something that you did that involved reflection and/or refraction yesterday. S- We took the aluminum foil and shined the light on it and it reflected back. T - It also caused the light to bounce back and bend in all different ways.	1B 2C 3C 7C 8C 10B 11C 13C 15C
	2	T1	0:08	F44 & 45 open book, describes what they will be doing today regarding light and color. S- F what? T - it's up on the overhead.	
	2	A2	0:09	T reads some from book. Place cellophane over lens... what is cellophane? S - it's like tissue paper. S - it's like a plastic wrap. T - Right and she shows them blue, green, and red plastic wrap. T demonstrates how they will hold the cellophane over the flashlight. T asks ss to write some predictions on a sheet of paper before they begin the activity. Begin with the red and write what you would expect or predict to happen when you shine the light through it onto the black paper. Repeat for blue and green. Ss share their predictions after they have written them. Ss felt that red would look red and blue would look blue. One s felt that green would look yellow when combined with the light. T - now predict what would happen when we mix the red and green. Ss - some say brown. T - Repeat for red, green, and blue. Ss - maybe brown (T maybe a darker brown since we added the blue?); black; I don't know; one felt they wouldn't see any color. Please do these in the order that we talked about it. Don't mix the colors until the end, I want your discoveries to be similar. You need to record what you see. T - what's the one thing that I don't want you to do? Ss - mix the colors. S - what about red and blue? T - you can test that last. S question about grouping. T - I'll assign that in a minute.	1D 2C 3D 4D 7D 8C 13C 14D 15C
	2	T2	0:20	Make sure everyone touches the light each time. T assigns groups. T passes out black paper,	

				flashlight and red-colored cellophane to each group.	
	2	A2 cont.	0:24	Lights off and ss work. One s turns off light and 2 others close the blinds. T - Ok, write down what you observed, the results. 0:26 S - We write down our results don't we? T - yes, write down your results. S - If our predictions are right can we mark a check? T- yes. 0:27 T passes out blue cellophane. S - the blue looks green. 0:28 T passes out green. All ss are working and most group members are sharing supplies. S-S I'll shine the light in your eyes... S - Does this look white or pink to you? (with all three colors together). Most groups finding that mixture of all three was a light purple or pink.	
	2	T3	0:33	Lights on. Person in group with first letter of name closest to Z may get all the materials together and return them. T gave reward to group that followed instructions well for returning supplies.	
	2	A3	0:35	T calls ss attention. Thank you for your attention and good group work. T called on ss to compare the predictions and results. Red was expected to be red and it was red. Blue was expected to be blue and most found blue but a few saw green. Green was expected to be green and it was green (one dark-green and one hazel). Red and green mixture expected was red and the result was red and some pink no matter the order of the colors. T- Who was surprised about the three colors mixed together? Most raised hands. T - I was surprised too. S - it was pinkish white; light purple. T- It was different from your predictions of dark brown or black wasn't it? One s predicted white and T asked why? S response inaudible. T - right there are some things that you can tell from white light. Under better conditions it would actually be white light. 0:42 T shares a prism - It's not a glass one, it's transparent, but it reflects. Each part reflects at a different angle. T holds it on the overhead and the light is reflected on the ceiling (as a rainbow). That white light has been broken up into the colors that make a rainbow. That means when you have white light it is made up of all colors from the spectrum. The prism breaks apart the light. Lights off while she showed the light.	1C 2C 3C 4D 7C 8C 10B 11C 13C 15D
	2		0:46	Tell me something new that you learned today. We are going to build on this after today. S- Mixing two colors of light I will not always get what I expect. S- The prism causes us to see all colors of the spectrum. T - why did that happen? S - you put it on the overhead. T - Because the prism broke the light into the spectrum. S- If you have a dark color in the paper (cellophane), it will show up better.	
	2		0:47	End of tape; bathroom break. T takes up notes from today and handout from previous day.	
11/10/03	3	A1	0:00	Ss finish snack as they begin Science. Review from Friday. T- What did I hold up to the overhead? And we saw something on the ceiling? S - it was	1C 2C 3C

				transparent. T - Good word. What does it mean? Ss - clear; you can see through it. T - what I had was a prism. What did we see on the ceiling? S- a rainbow. T - Why did we see a rainbow? Is my overhead a rainbow overhead? It took the white light and broke the colors apart. (sketched on overhead). What colors were there? S - rainbow colors. T - right, violet, red, and blue. Referred to prism on page F-47 for reference. S - did you say that the colors in the rainbow were primary colors? T - They are a mixture. S - what were they called if they weren't - like the opposite of primary? T - Secondary colors.	4C 7C 8C/D 10B 11C 13C
	3	A2	0:05	T reads segments of book. Rainbow comes from white light from the visible spectrum. The book discussed how prisms can be used to form rainbows. If you are seeing red or red light, you know that red is the longest wavelength. T asks 2 ss to come to the front who had red shirts on. The wavelength of red light in this shirt is longer than any other color. Repeated with ss wearing blue and yellow. What is the color of the longest wavelength that you are seeing? Ss responded correctly. T - continues reading: Violet has the shortest wavelength and red has the longest. T added You know what certain colors are because we have named them. T - reads about colors of objects. T Added: What is the longest wavelength you are seeing with the red apple? Ss- red. T reads - opaque vocabulary term. T gave examples of opaque objects in the room (book, aluminum can, etc.). T reads - Opaque objects behave differently from transparent objects. They absorb some colors of light. What color of light is reflected by a green apple? T gave wait time. T - let me tell you about a red apple one more time. All of the colors are absorbed with the exception of red which is reflected. So about the green apple, what color is reflected? Ss - green T - Right. Maybe a little yellow and orange. What will be absorbed? All of the other colors in the spectrum besides green.	1C 2C 3C 4C 7C 8C/D 13C
	3	T2	0:18	T asks ss to put snacks away.	
	3	A3	0:19	Page F-46, Instructions for activity. T writes on overhead what they should do in the activity and notes they should write on their paper. 1. Write the objects and their colors; 2. Predict what color they will look through different film (cellophane). T - for example, I predict that the blue item will be purple with blue film. Work as a group to predict what will happen. 3. Use blue, green, and red separately and then combine the film together to see what the color of the objects look like. Answer #1-4 on page F-46. 1. How does each filter affect the objects that are of the same color. 2. How does each filter affect the objects that are of a different color. 3. The white light shining on objects contains many colors. From your observations, make a hypothesis about why you think objects appear only one color. 4. Use your hypothesis to explain why some objects are black and some are white. T asks if hypothesis has to be the correct answer? Ss- shake heads no. T explains that a hypothesis can begin, I think that...; How else can you write a hypothesis? S - you can use a chart. T - Good, how else? S - I predict...	1D 2C 3C 4D 7D 8C/D 13C 14D 15C

				S asked question about grouping. T -What can you do if you forget what to do? S- look on page F-46. T - Good it's written exactly as how you should do it. T asks ss to focus on the objects and not to play or throw the objects. The objects should stay on the white paper that is handed out.	
	3	T3	0:27	T assigns groups and hands out white paper to each group. T hands out objects to groups - 3-4/per group - different colored paper cut outs, water bottle, stuffed animals, tissue box (*Sponge Bob Square pants*), etc.	
	3	A3 cont.	0:28	Group work time. Ss list the objects and their colors and predict what color they will be with each color filter. S questions about what the name of some objects are. T tells them that the actual name doesn't matter, they can name them. Ss discuss as group what they should name things (they are trying to use accurate spelling). Some ss make an open list while others create a chart to record their data. 0:32 T has passed out all of the objects and reminds ss that they should be listing and predicting about the objects. S - My hypothesis is... you spell hypothesis like..	
	3		0:37	T passes out blue filter to each group that has finished listing and predicting. Ss hold the filter over the objects and compare the results with their prediction. S- My prediction was that the blue filter held over the green water bottle would be blue. It was actually green. (Ss have different methods for recording their data. Some are difficult for me to understand just by looking, but they understand what they have written when I ask.) 0:46 T compliments a group that has been working very cooperatively and have been moving through the tasks smoothly. Majority of ss working and on task. One group (1 boy and 2 girls) two girls working together and the boy working by himself.	
	3	T4	0:51	T - 5's please (hands up) - you should be about finished with the filters and working on number 1-4 at the bottom of the page. We will share those in about 5 minutes. A s reminded T of chorus - several ss had to leave for chorus. T decided to go ahead and discuss the questions orally since they were running out of time quickly. Some ss working on questions while they are waiting for instructions. T asks them to stack materials to the side of the desk.	
	3	A4	0:53	Discuss questions. T - When we used the filters and looked at objects, what did we discover? S - Green on yellow makes a lighter green. T - Did anyone else discover this? S - When you put blue and red together it will give you a dark purple. T- Does that make sense to you knowing what you know about colors? Ss - yes.	1C 2C 3C 4C

				S- the light green napkin and the green filter made the napkin appear a darker green. T - asked about red filters with red objects - they stayed red. Repeated with blue. T - what did we learn about light and color today that would help that make sense? If you are looking at this (blue ribbon), the longest wavelength of color that you are seeing is blue. T holds up red bowl - if you are seeing red then red light is being what? S - reflected. T - This is the same even if you use the same color filter. What colors are being absorbed? Ss - red; all different colors. T - and the same with the filter over it. T asks if the same colors are absorbed and reflected for an object when a different color filter is held over it. Ss- say no. They practice this with blue and green mixed and others. T- who has questions? S - What would the green napkin look like under the red? T - what color is the napkin reflecting now? S - green T holds red filter over - what color is reflected now? S - a different color. T - Question 3 - What kind of hypothesis can we make? S - If you look at something green through a blue filter it will be a brown color. T - that can be a piece of it or an example. T asks other students. S- Red objects show up red with the same color filter. T - and that's the same for blue with blue and green with green and so on. So each color reflects it's own color under the same color filter. T asks ss to think tonight about why they see black and why they see white. S - Do we have to write it down? T - no	7D 8C/D 10B 11C 13C
	3		1:04	End of tape. Bathroom break.	
OVERALL COMBINED LESSON CODES					5D 6D 9D 12D 16C 17D 19B 20C 21B 22D

Bulletin Board or on walls- Simple Machine student -made posters (unique); pictures of students making graphs (in hall), Graphs made by groups of students regarding class statistics, Fabulous Fall work (individual student assignments posted), Great Wall of Ideas (Project Grad)
Teacher-made posters: Story chart (author, vocabulary, etc.), class rules,
Store-bought posters: Multiplication chart, Birthday poster, Helper Bulletin Board (Project Grad), Vine of Kindness (Project Grad), Poster of the United States, Computer assignment poster (w/days of week different ss are assigned to the computer)
Dictionaries, Encyclopedias, 4 computers ; White Board in back of room dedicated for messages and daily assignments in each subject

Appendix J.9 - STAM Record of Activities Pre-Observations Laura

Date	Tape	A or T	Start Time	Description	STAM Code
4/14/03	1	A1	0:00	*Before taping, ss had written Newton's 1st law (Inertia: the tendency of an object to keep in motion when a force acts on the object) as part of their notes and conducted introductory activities that demonstrated the law.* The ss had been working w/marbles in plastic cups - and as taping began the class was discussing inertia. T- So do we need to change our rule a little bit to say that when an object is *(ss say moving)* unless something *(ss say stops it)*, it will keep on moving. Think about the seat belt - do the seat belt thing again. Ss practice moving the cup with the ball in and then stopping the cup - the ball rolls out. S responses, they talk about what they think inertia is - It's like inertia, is the tendency of an object to keep moving, unless a force like a seatbelt or something stops it T - Give me inertia again. S - When an object is moving - unless something tries to stop it - it will keep going. T - Does anybody need to add anything or change that? Is that the same rule for if it is still? Ss (several) - no, one s says so it's both things, if it's still it will stay still or if it's moving or keep moving. T- so do you think that's the rule, that that's what Issac figured out? Ss - yes T- So you have two parts of Issaac's law. So the two types of forces that we talked about what are they?- a push and *(ss say pull)*. Are there other forces besides pushes and pulls? T suggests climb, stretch, hug (all either a push or a pull). Do we need to write that down? One s is writing it down and I'm not up at the board so write that down. I think that's good. S - Is this part of number 2? T- this is still Newton's first law.	1D 2D 3D 4D 7D 8D 10D 15E
	1	T1	0:07	The T describes the next activity that they should complete. Ss are to use 2 Ping pong balls and 2 golf balls that they have on their tables. T - You will sit on the floor like you are playing with your niece or nephew and I want you to roll these balls in an attempt to make them hit each other. Experiment with different ways and see what happens. One roll fast, one roll slow, etc.	
	1	A2	0:10	Ss working in pairs on floor to determine what inertia has to do with changing speed and direction. Feet touching, legs apart. T- we need to use two of the same balls; either two ping pong or two golf balls - I don't think I	1D 2E 3E

				made that clear. S-S: When you roll it slower and I roll it faster and hit, both balls move toward you. S-S: If they both are going at the same speed they go out to the side. If they are going at different speeds, one keeps going and the other one stops.	4E 7E 8E 10E
	1		0:17	Group discussion of paired practice. T - Talk to me about what happened; you don't have to be like Einstein, just tell me what you saw. S - When the fast one hits the slow one, the fast one stops and the slow one continued moving. T said interesting and repeated it back to class S - When we rolled both slow they bounced back to us. When we rolled one fast and one slow, for us the slow one stopped and the fast one kept moving. T commented on the different results that the groups discovered. It seems to me that we had some different results happen, so what do you think caused the different results? S- Sometimes the balls are spinning, they might be going a different speed, they could roll it from a different spot (T - says direction), different angles, distance. 0:21 T - Let's look at this for just a second and writes on the board. Two balls. So there's basically two different things that can influence. Speed and direction (from what you've told me). If you have two of the same mass balls, or objects, what are the two things that can affect when they meet each other? Speed and direction. How do these things fit in with Newton's first law, inertia? We've talked about things that are sitting still and what has to happen to make them move, we've talked about things that are moving and what makes them stop, what did we do here? What had to happen to the ball to make it change speed or direction? It starts with an f. S - a force. T - very good. So give me an inertia law for something that is moving and what has to happen to make it change speed or direction? S- Something has to hit or be hit. T- what do we call that hit? When an object is moving unless what happens. T calls on a s and gave some wait time... Ok back with your feet together, let's try again.	13E 14E 15E 19C
	1		0:26	Paired partners work together as directed. T - We're trying to figure out a law about what inertia means to a moving object and changing the motion of that moving object. We are going to do a slow roll so that you will know they will hit. Talk about it with your partner to come up with a sentence. All groups discussing and practicing with the balls.	
	1		0:30	Group discussion of paired practice. S - Is it like when you're playing baseball, you hit the ball with the bat and the ball changes speed and direction?	

				T - yes because the baseball bat is a force. (One student compares it to hitting ball with a bat, soccer ball) T gives s a sucker for response. S - We think that unless a force interferes with an objects path, it just keeps going continuously. T - What you've said to me so far, when an object (baseball or soccer ball) is moving it's going to keep moving unless something else hits it and changes the direction or the speed of the ball. 0:33 Ss return to tables and T has them derive Newton's first law. T asks ss to say rule in own words. One student points out that the objects need to be same mass and this misconception was addressed. T - Look what we wrote the very first day - "Inertia is the tendency of an object to keep it's motion unless an object acts on it." Does that work for objects that are sitting still? Ss give examples of this, an object is still going to sit still unless something hits it. *(0:38 another class comes through room- majority of ss ignore this and continue paying attention.)* T- how does the seat belt experiment compare? Remember when we learned about the scientific method and we learned about controls - well one of the controls in the experiment was one marble in the cup. With our experiment of one person in the car - why does the person keep on going. The person is still moving when the car stops. Explain that in terms of inertia. S- The force has to be stronger in order for the movement to stop. T - When something is still or moving - we call that motion. What's the speed of this when it's not moving, how would you measure it? - 0. T asks ss to give definition in their own words. S - An object will keep going unless something stops it. T- does it have to stop? S - An object will keep going unless something stops it, slows it down, or changes it's direction. T- very good, excellent. One student starts with tendency and T says no I want it in your words. S - An object is going to stay in motion unless it's slowed down, stopped, or changes direction. T- by a what? S- by a force. T- who else wants to try, the more times you hear it the easier it will be for you to remember it.	
	1	T2	0:45	T - I am so impressed with you. T - put the balls back in the cups. Bring papers back tomorrow and we'll do Newton's second law. Proud of you and have a nice day.	
	1		0:47	End of Tape. Class exits as new class enters	
4/15/03	2	T1	0:00	*Newton's 2nd law was introduced prior to videotape observations.* Ss have written down Newton's second law on note sheet. T- has discussed it with class and directs	

				them to sit down on floor to practice applying the knowledge with ping-pong and golf balls. *Notes:* F=ma The force of a moving object depends on it's mass and how fast it's moving. (T put in moving even though it's for both still and moving objects - T felt it was important for them to try to understand the concept)	
	2	A1	0:01	Ss practice rolling the balls and discussing Newton's 2^{nd} law in pairs. One student uses the ping pong ball, while the other uses the golf ball. Ss show T what they are discovering. S - when I roll the golf ball really slow and he rolls the ping-pong balls fast they just bounce off of the golf ball and it keeps on moving. T- Wow, that's a good experiment, I haven't done that one before. Another group, S-S Ok you roll yours very fast and I'll roll mine slow.	1D 2E 3D 4E 7E
	2		0:06	T- So tell me what you saw. What's different about two ping-pong, or two golf balls, and one of each? I wonder what caused them to go into different directions? Ss - maybe the masses, or the speed. T- so there are probably several different factors. Any other fun experiments that you tried? One group had tried spinning the balls. T- Do you think that would happen with two of the same kind of ball? 0:12 T suggests they try it, so the ss try. 0:13 T - What did you see? S - if one is spinning harder it changes the direction of the other. T- does that make sense to you, can you talk about it? S - maybe one of them has a bigger force; the one that is spinning faster has more force. T- I think maybe you have the answer.	8E 10E 14E 15E 19C
	2	T2	0:16	T asked Ss to move back to seats. T- So what did we learn about objects that have greater mass, with Newton's 2^{nd} law? S - They have a stronger force. T - This guy was pretty smart.	
	2	A2	0:18	Discussion and demonstrations of Newton's 3^{rd} law. The T blows up a balloon and asks the ss to predict what would happen when she let go of it. Some predictions in all directions. Balloon moved to the right. T - Why did you predict that it would go right? S explains. T- she has a theory, should we test it? Chair example, If I sit and push my feet forward the chair moves backward - asks all ss to try. How come when I push on the wall, it doesn't move? S - the wall has a bigger mass. T - have you sat on a swing and tried to swing w/out moving your feet? Several ss talked about it. You've just explained Newton's 3^{rd} law. (0:26) T-writes "Every time there is a push or a pull" on the board and then she asked the ss to tell her what happens. T-finishes it on board, "in one direction there is an equal push or pull in the opposite direction." (Ss write it on their paper w/out being asked to) T asks for other examples	1D 2D 3D 4C 7D 8E 10D 13E 15E 19C

				from ss. They suggest an airplane, a jetpack, swimming. T - Think about it when you swim, when you push the water in one way you move the other direction. S - Then how do you drown? A s suggests the water cycle as another example of the 2nd law and T says that's not really an example. T -Action/reaction (short-hand version).	
	2	T3	0:36	In the 15 minutes left, take 5 minutes per law and explain the law to your partner- talk about it, explain it, and show an example with the materials that you have. Help each other if you are having trouble. T briefly describes tomorrow's activity regarding energy and rubber band racer cars and showed them the bags for the cars.	
	2	A3	0:38	Paired practice of Newton's 3 laws of motion. Ss practice 1st two laws and then talk about it. For 1st law, some ss use index card and penny to demonstrate to each other; others use marble in cup - like the seatbelt demo. 0:43 moved to 2nd law. (One group uses seatbelt example to describe the 2nd law.) S - We found out that size doesn't matter, it just depends on mass and acceleration, like with the marble and ping pong ball. 0:45 Group discussion. T- two groups have discovered things we didn't practice in class. She asks one group to describe. (Some ss talking and T asks them to focus so they can learn something) One student uses an analogy to magnets, repelling and attracting. 0:48 T gives balloons to all and then they practice the 3rd law; they return to seats for this one. Ss blow up balloons and then describe to partner what will happen according to the 3rd law.	1D 2E 3E 4E 7D 8D 10E 13E 14E 15C 19C
	2		0:52	Group discussion of 3rd law continued. T- final question about Newton's 3rd law. Do you understand that once you get past earth's atmosphere that there isn't any air? Astronauts float around - there's no gravity, wind, or air. It's like a vacuum. Do you understand that there is no matter in a vacuum? Blow up that balloon? There is now matter in that balloon. How can the airplane do that and then the space shuttle also when there is no atmosphere? S - I don't know, I've never thought of that before. S- It's the force that is coming out the end. T- It's a contained system (balloon + air). S - How about a butterfly? It works like swimming. T - Right, when the wings push down the butterfly goes up. S - Why can't we do it in the air like birds? T they are so much lighter than we are and their bones are hollow - God made them perfect for flying.	

	2		0:58	As class ends, T asked for all balloons before they leave. She told them to wear something they could crawl around on the floor in - in case they got to building the cars. End of Tape.	
4/16/03	3	T1	0:00	*Before taping began T began review of Newton's 3 laws*- ss given a piece of gum for giving examples. Tennis was used to show an example of each law. T asked back row of ss to move closer toward board.	
	3	A1	0:03	Class discussion of energy types and definition for energy. T - Since we have been talking about all this movement we are going to talk about energy - Asks ss to give all the kinds of examples of energy they can think of that they know about. Ss suggest: Lightning, toaster oven, washing machine, anything that runs on electricity, kinetic (moving), potential (stored) (like with the roller coaster example), physical (Mechanical). T elicits others when they slow down (what about the sun); Ss say solar, and then come up with chemical, nuclear, water, air/wind, light.	1C 2D 3D 4D 7D 8C 10C
	3		0:08	T - What good is all of this energy to us? What does a battery do for the energizer bunny? Ss - Keep going. T -What does good healthy food (chemical energy) allow our body to do? Which allows our bodies to do what kind? mechanical. Solar energy allows plants to make what kind? chemical energy. In East TN, water helps us make electricity. Ss say hot showers, clean water, clothes, Nintendo, etc. T points out connections between the different types of energy. Let's think about how lucky we are to have all of these things. Compared the poor in our country to poor in others - our government has places for people to go to get things. As compared to Baghdad and looting going on right now. The poor here are often better off than the richest in other countries. T points out that machines have to do work in order to do job.	15C
	3		0:15	T- OK somebody give me a definition for energy. S - something that does work, gives power to do work. T- Ok, let's write something down. Energy = the ability to do work (1 s - not writing, but watching and participating.) T- The younger you are the more energy you have, but I find that the more I exercise the more energy I have. Some of you earlier mentioned some words that we are going to use again that made me think you have studied about energy before.	
	3		0:18	T - I'm holding an eraser - does it have energy? Some say yes and some say no. Is it possible for it to do energy? What about this penny? What if I shoot it out of a gun against the wall at speeds of 1 mile an hour, 10, 200 to hit wall - can it do damage? So does it have the chance to do something? Ss - yes. T - They have the potential to do damage and it's called potential. 0:21 New s advised not to blurt out.	

	3		0:24	T - Now this eraser has energy, why? Because it has potential, it is stored in the object and hasn't gotten used yet. Wrote on board: potential energy=stored energy. You can use what you know about Newton's 2nd law with potential energy. If you go to pick up noodles and spaghetti sauce and they both drop on the floor which would have more potential energy? S - The sauce. T- why? S - Because it's heavier. T - you've just taught me something - Added to potential definition - amount of stored energy depends on amount of mass.	
	3		0:28	T - OK, next example - I need a couple of assistants for this. T has golf ball. Ok when do you think it has more potential energy in the ball when it's on the floor or in my hand? T- why on the floor? S - it can roll. T - When it's on the floor what keeps the ball from moving? S- friction. T- Does anybody want to change their answer? When it's on the floor it has 0 potential energy. Watch what happens. Assistant dropped ball and looked at where it bounced to. S- Each time it bounced, it lost some of it's force. (A s compared it to a roller coaster example).	
	3		0:34	What did you tell me the energy of movement was? S - Kinetic energy = moving energy, energy of movement. Ss talking about centripital force on their own while T goes to get golf balls. T hears and suggests that they go to www.learner.org/parkphysics (Annenberg) - they can put together the parts of a roller coaster and play around with Newton's laws. Some ss write it down.	
	3		0:37	T draws hill picture - You will see this in all kinds of textbooks. What kind of energy does it have at the top of the hill (ball in hand)? S- potential. T-While it's rolling down the hill (dropping ball)? S- kinetic. T- What kind of energy does it have at the bottom? Ss guess. T- None - because it's sitting there doing nothing. Think of the force of an object as it moves and Newton's 2nd law. Let's think about this as you will be building your cars. Will a car with more or less mass have more potential energy? S- more.	
	3	T2	0:43	T passes out ping pong balls and directs ss to stand up; each pair bounces the balls and watches it. Instructed to drop from shoulder height.	
	3	A2	0:44	Paried practice and group discussion T - Let it keep bouncing until it's bouncing about 1 inch from the ground. S- it starts bouncing faster each time.	1D 2E 3D

				T- demos the golf ball. 0:48 T - Let's draw a picture. Why did we drop from the shoulder? S - to keep it consistent. T - What kind of energy did the ball have when it was held at the top, while falling, and at the bottom, while going back up, and then at the top before it starts coming down again? T compares to playing tennis and how the ball actually stops when it goes up. T- Also compared to swinging and how you are weightless at the top. S compares to roller coasters and how they give you that feeling too. T - Up in the air and we aren't moving but we have the potential... S- Do we have to draw all of that? T - you need to draw enough to get the pattern.	4D 7E 8E 10D 13D 14E 15E 19C
	3	T3	0:55	T asks ss to take 2-3 minutes and talk to each other about how potential and kinetic energy are related and how kinetic is related to Newton's 2nd law. If you want a ping pong ball you can use them. Many ask for one and they practice.	
	3	A3	0:56	Some ss stand and practice, others draw ideas on board. S -s What kind of energy when it's rolling? S- kinetic. T - kinetic, anytime it's moving it's kinetic.	1D 2E 3D
	3		0:59	T calls for ss attention and they return balls. T - Tell me honestly if when you discussed that with each other did it help you? S - It helped, having someone else say it. T - What other things did you learn. Ss- There are lots of types of energy; when the ball rolls it is kinetic.	4E 7E 8D 10D 13E 14E 15E 19D
	3	T4	1:01	T selects ss to work in groups on building cars for the next day. She selects 4 groups of 4; if you were together in the problem solving club you can't be together tomorrow.	
	3		1:06	End of Tape.	
4/17/03	4	A1	0:00	Students working in their groups (5 groups) to build Kinex cars using a poster guide/picture. (Groups adjusted since previous day) S- We are assembling the parts and then we'll connect them together. S-s that's not how you put it on there. S- yes it is. Each group is busily working together. Ss inform T if they are missing pieces, later they get pieces they need without asking.	1D 2D 3E 4E 6E 7E
	4		0:13	Group getting loud - T cautioned them; One group finished with car and practiced some in classroom. While testing it they found they needed to strengthen some parts.	14D/E 15E 19D
	4		0:19	2nd group finished car; T took their picture (digital camera). Other three groups struggling some	

				with car building. 2nd car needed to reattach wheel after testing it.	
	4		0:23	T- instructs one s in particular to use self-control to go in hall to test cars. Different members of each team practiced racing the cars. First, they tested the distance that the cars traveled and then they tested speed.	
	4		0:28	T- checks on ss left in the classroom, ss wait and when T comes back, the ss continue to test. 0:29 3rd group brought car out for testing. T- looked at car and said they could test.	
	4		0:32	Groups remaining in classroom - 1st group that had car finished is trying to improve car; In another group, one boy is working and 2 girls are drawing on board - girls say that the boy is trying to do it all. T returns into classroom and tries to help one of the final groups figure out what they can do to finish the car. T - Look at the picture and see if there are enough spacers added to the wheels, that will make a difference. The fourth group finishes and car drives. Group 5 is at frustration point - girl from Group 2 tried to help them. Group 1 - wanted to add more wheels - T - told them they couldn't add more parts than the other teams; they continued testing in the room. Group 3 - troubleshooting, s-s why don't we just build the whole thing over? S- no! S- I thought this would be fun. S-it's fun but it's hard. Group 1 changed wheel. Group 5 - 2 members fussing at each other, 3rd member is trying to tell them it will be OK.	
	4	A2	0:42	Closure T calls for attention. Pleased with work for completing cars. Ss should place cars back in bags and they will continue with them next class. T asks ss to sit down and listen to her. What kind of energy are we using with these cars? S -Kinetic when it moves. T- What about when we wind up the rubber band? S- mechanical. T- What about what is stored in the rubber band? S-Potential/ T- Thank you for working so hard.	1C 7C 8C 10B
	4		0:46	End of Tape	
OVERALL COMBINED LESSON CODES					5E 9D/E 11E 12D 16C 17D 18D 20C 21B 22D

Scientific method/process bulletin board, Clouds bulletin board, oceans, maps, Ground water poster, Astronomy chart, percent/decimal/fraction/ equivalents chart,

Teacher comment Day 4: Usually I would review on energy first, but I will do that at the end and talk about the rubber band having stored energy. They got the materials, work in teams to build the cars, and she couldn't help them.

Problem solving club - in-school club. Use straws, popsicle sticks, etc. (donated)

Other: She has found that if she questions them while they are in the situation that they can respond better than if she asks them to return to their seats and then respond. "They are at such a concrete stage."

Appendix J.10 - STAM Record of Activities Post-Observations Laura

Date	Tape	A or T	Start Time	Description	STAM Code
10/7/03	1	T1	0:00	Ss enter room. Returning from special area class. Previous 4 days of class they have taken notes in the library on Simple Machines in journals. T asks them to take out their investigation notebooks (journals) as they enter class.	
	1	A1	0:03	T prepared overheads prior to class of key ideas and pictures that ss should have in their notes. Ss are asked to highlight the ideas and pictures that they have in their notes and to write down and highlight the ideas and pictures that they don't have. S - I used move up at a slanted angle, is that the same thing as (inaudible)? T - let me show you the comparison on the board. T raises overhead screen and writes on the whiteboard. If you have a 300 pound box and want to lift it up to a higher surface would you use this ramp or a longer ramp (a sketch was drawn as she described this). Ss- the longer ramp. T - A lower angle and longer distance - that's what two ramps of different lengths up to the same height in the notes means.	1D 2D 3D 7C/D 8E 10D 12D 13D
	1		0:08	T- How many of you already have something about friction in your notes? Several ss raise hands. T asks S to repeat his response - The surface matters on how much or easy it is. T - Good, so the surface matters doesn't it? Would you rather push that box up with a surface of rocks or oil. Ss - oil. T- How about a ramp with sand paper or a ramp with metal. Ss - metal. One s (volunteer) - I'd pick sandpaper because it wouldn't slip down, but it would be harder to push up. S - Would it be right to say that a ramp is a device used to move something from point A to point B? T- Yes, but so is a wheel and axle and a lever. All the simple machines are designed to move something and to make our job easier, aren't they? And the idea here is to look at each simple machine and see how they do it, because they each do it in a different way. So from point A to point B is fancy and if you have a picture of it that shows point A and B then that's even better. S - that's what I did. T - Then that works, good. You need to have a working understanding of how a ramp works and if your working understanding is moving something from point A to B, then that's too general, OK. I understand you have a picture, but two weeks from now if I ask you to tell me the difference between how a ramp works and how a pulley works, are you going to be able to tell me? If you tell me that a ramp moves something from point A to B, so does a pulley. So you want to deal with the angled or slanted surface and the height part, moving from low to high and the amount of distance - it changes the amount of effort you use.	14C 15C 16C
	1		0:12	S- Does a crowbar ever become a simple machine? Ss - it is. T - It is a simple machine. A	

				crowbar could become a compound machine, couldn't it? S - Yeah, because if you have a nail you want to pull out it's a compound machine. T- If you use it on a nail you use it as a what? Ss - a lever. T retrieves a crowbar that ss had access to earlier in the unit. T- when we used our weenie crowbars earlier. T takes it to the window and places it between the window sill and wall. T- what type of machine is it now? Ss - simple machine, lever, wedge. T - I heard that Shawn, good a wedge. S- and then a lever. T - Good Jessie and then a lever. T - so then we can call it a compound machine when we are using it that way, but to take a nail out the crowbar is used as a? Ss - lever.	
	1		0:14	T - Do you have moves a heavy object from a lower to a higher place? Two examples, a moving truck and a handicap ramp. T tells story of a friend she took out on a wheelchair and riding on the back of the chair down a hill. When they hit a ramp it knocked her friend out of the chair. T- What do you think happened? Several ss attempt answers. S- It was too much of an angle. T - Good, it was too much of an angle. The ramp was so short and there wasn't even a dip there where the ramp met the road. It's just that the ramp was so short and we had to move up so fast that it knocked her out of her seat. I probably shouldn't tell you stories like that but it sure fit with inclined planes.	
	1		0:18	A student starts distributing hand sanitizer for ss to use before lunch. Without being asked and without distraction. Do you have this picture in your notes with arrows and labels? Longer distance you use less force; shorter distance, you use more force - that's the key to inclined planes. S question - inaudible. T - guys you are getting highlighter crazy. Don't highlight everything in your book, just highlight what's in the overhead notes. The whole point of highlighting is to make what's important stand out.	
	1		0:20	Change to wedge notes. Overhead notes - a type of inclined plane; thin at one end, tapering to a thin point at the other end; the longer and thinner the wedge is, the less force you use to use it; instead of an object moving along the inclined plane, the inclined plane (wedge) moves. Ss check their notes for these ideas and add them if they are not there. T - does this describe an inclined plane as well. S - sure. S (volunteer) - did you know that there were mainly 3 types of chisels? T - no, I did not know that. What are they? S - It didn't give names but it had pictures, so I drew them. T looks at them and says cool and I'm impressed as the s describes them. T - What's the biggest difference between a wedge and an inclined plane? S (raises hand)- On an inclined plane you move the object and on a wedge the wedge moves. T asks several other ss to repeat what was said.	
	1		0:23	Ss go to lunch. End of tape.	

10/10/03	2	T1	0:00	Ss meet in classroom and are escorted as a group to the computer lab. The ss have been in the computer lab for 2 days prior to this lesson, learning how to use the software, *Inspiration*, in order to create concept maps for the different types of simple machines. They also looked for simple machines pictures on websites that could be used in their *Inspiration* maps.	
	2	A1	0:05	T asks ss to check for a file/folder labeled *teacher* on the desktop. T- if we are going to get anything done today, we are going to need to stay together. Yesterday in bus duty I asked several ss how they felt about the past two days in the computer lab. They felt they weren't making good progress. I asked if they wanted me to find some simple machines pictures and put them in a file for everyone to use and also walk-through making a map together. And they said yes. So I'm prepared to do that step by step as a class. If you choose to work on your own that's Ok too. Raise your hand if you would like to do this together as a class, on your own. 5 chose to do it on their own. Moved some ss as necessary so they could be at a computer with a *teacher* file.	2C/D 6C/D 7D 8D 10B 12D 13B 14C
	2		0:11	Open *teacher* folder to investigate what's in it (double left click). Two ss moved to different computers (folder did not work). T name - simple machine pictures. Open a folder Click view, as webpage. When you click on one of the icons it will give you a preview to the left. Troubleshooting with individual ss to help them with this process. S - Are we going to have time next week to work on this? T- no, the computer lab is full next week. T- removed lanyard a s was making during class. T asks ss to minimize the picture folders	15A 16C/D
	2		0:20	Open *Inspiration*. Let's make a map on inclined planes. Open up the picture folders again and open the inclined planes folder. Find a picture that is a basic/general inclined plane picture that can be used for the main idea bubble. A picture that can stand for all of them. Once you pick one, raise your hand so I'll know you are ready. T helps some ss troubleshoot and have the pictures show up as a preview. 2 ways to insert pictures. 1. Double click on the icon. Right click, left click on copy (several ss have trouble with the right click instruction), close window. Open Inspiration, click on white space and right click, paste. 2. Edit, insert graphic, find T file, find T name file, find inclined plane file, and select and open picture. T - Which way do you like better? S - the first way. T - Ok you can do it that way. T shows s how to resize picture.	
	2		0:27	Now you want to introduce inclined planes next. So we are going to take out our investigation notebooks and what will we say. S- what we wrote down. T - we are going to type, "what we wrote down" in the text box? Ss- no. T - How will we introduce inclined planes? What is an inclined plane? (wait time)	

				Teacher helps s troubleshoot.	
	2		0:29	Ss go to lunch. Stop tape.	
	2		0:29	So everybody has a bubble that says main idea and a picture on your screen. Demonstrates how to move the picture around, resize bubbles, change background colors, group symbols, - ss practice these and T helps individual ss as needed. Create text box inside bubble (click on A at the bottom and then click and drag inside the bubble to create a box). Select 14 for font size. T typed in a basic description of inclined planes. Ss copied this for their description. T circulated and helped ss as needed.	
	2		0:45	Raise your hand if you are ready to move on. Raise your hand and tell me what problems you are having. No one raised hand. T- When you type in the box the words automatically center. T demonstrates how to highlight and select the text and left justify. Group the text box and your bubble so that the bubble can be moved as one.	
	2		0:50	Click in the white area and create another bubble. T stopped to help a student group his text and pictures. Go back to inclined planes folder and find a picture that represents a ramp. Reminded ss about right click and copy for pasting into their map. Place picture in bubble and type description of ramps in a text box. As ss work on this part T circulates and assists as necessary. Some ss help each other with steps.	
	2		0:58	If you would like to print what you have make sure your name is on it. (File - Print). T will save printouts and bring them to the next class. We are 5 minutes late to the next class.	
	2		1:02	End of Tape	
10/16/03	3	T1	0:00	Morning announcements, moment of silence, pledge. T collecting paperwork from ss. 3-5 ss are grouped at one of 6 stations around the room - Inclined planes, friction, pulleys, wheel & axle, wedges, screws, levers. There is a drill setup at the lever station to allow T to make adjustments as needed to this station. 2 hearing impaired ss and an interpreter are in this class	
	3	A1	0:03	Ss are told that they can begin working on their stations. They have 2 or more numbered folders at each station. Ss are to work through each folder at the station. Ss share materials and work as teams at each station. As they finish working at each station they are required to clean it up for the next group to use. Wheel and axle station - 3 folders color wheels red and axles blue. T- you've got to think about it. The part that moves the big distance is the? S- wheel. And the part that moves the short distance is the axle.	1D 2D 3D 4D 6D 7D 8E
	3		0:11	Wedges station - 3 girls. 2 girls were in TAG and 1 had completed the work the day before. A wedge is placed between two books and pulled with a bungy cord. One person pulls on the cord	10D 12E

				until the books begin to move. Measure from where the bungy cord started to where it pulls back (they weren't finding the difference). (Me) What are you measuring? - S -It measures the force in inches. How much force you have to use to pull the wedge and separate the two books. They are testing two different wedges.	13D 14D/E 15C 16C/D	
	3		0:16	Inclined Planes station (3 girls, 1 boy) Tilt wood planks of 3 different lengths (one at a time) on a crate. Hook a block on a bungy cord. Place the block at the bottom of the plane. Pull on the cord until the block starts to move. Ss explained to me what they were doing - Measuring how far it stretches before the block starts to move. T w/group. T - The thing you are testing or the thing you are comparing is what? S - the bungy cord. T - that is what happens, the responding variable. (points to where they will record this information). The thing you are comparing is what? The length of the? Ss - boards. (24, 36, 48 inches each). Ss had connected two blocks and T asked them to select one large block to use instead. T - how will we know how much the bungy changes? S - you have to measure it. S uses measuring tape to measure the length from inside the coil on one side to the inside coil on the opposite side (as suggested by T). T - that's nine inches. Let's see how much the bungy stretches when you pull it straight up. 12 inches. What's the difference? S - 3 inches. T - So, the amount of stretch tells you the amount of force. Let's see if you get 3 inches when you pull it up the ramp. What do you think will happen? (0:25) S asks for different screws??. T says they are in a box next to the microwave. Do you think we will get a 3 inch difference when we go up the ramp? Boy and one girl- said more (explanation is inaudible). 2 girls - said less. T - why less. One girl said because you are not going straight up, you are going up the ramp and that's easier. Boy changes his mind and agrees with girl. T- I think you might be right. 0:27 T- Let's try it. We'll need everyone to work together. One to keep the board from falling, One to pull the cord. One to hold the block until it starts to move. We need to measure the bungee cord again, why? S - because it may stretch. It's still 9 inches. They test the block on the ramp. The bungee cord stretched to 10 inches, with a difference of 1. S- so that didn't stretch 3 inches. T - which way is easier? Ss- the ramp because it only took one inch compared to 3 inches to move it. The group practices for a few more times before she moves on.		
	3		0:31	All groups are working on their stations as T is working with the inclined planes group.		
	3		0:32	Friction station - 5 boys Different surfaces, block Ss appeared to be finished and cleaning up their station. I asked them to explain what they had accomplished. They attached a block to a bungee cord and placed the block on each surface. They compared the difference in the stretch of the cord using the different surfaces.		

				Worksheet and their responses: Manipulated variable is the different surfaces, Responding variable is how friction affects the movement, and the controls were they used the same block, with the same force and the same distance. (possibly accurate with more questioning)	
	3		0:35	Levers station 4 girls Teacher made fulcrum, board to balance on the fulcrum in different areas, 3 different sized weights (sand in small, medium, and large ziploc plastic containers) T had moved to the levers group to repair the block of wood that was being used to balance. It needed more holes - she had a drill hooked up. The screws in the fulcrum had been tampered with the day before as well and needed to be reinstalled. I asked the group what they were doing at the station. S - We are finding out about the 1st, 2nd, and 3rd class levers and where the fulcrum is in each. Moving the fulcrum can change the amount of effort. 0:37 Wedges group appears to be finished. They are not at their station.	
	3		0:38	Pulley group - 4 boys Fixable and movable pulleys, gallon of water. Ss compare the amount of effort to raise the water with each type of pulley. What are you learning here? (me) The movable pulley is easier. How to make a clothes line that works.	
	3		0:41	Lever group again. Ss are trying to fit the board on the fulcrum.	
	3		0:43	Wheel and axle group is not at their table. T is back with inclined planes and looking over their data.	
	3	A2	0:44	T asks for attention. I have one group that has finished two stations, while the rest of you have not finished one. The levers group needed modifications so that's different. You have to remember this is a problem solving class. You solve problems everyday after school. I'm asking you to bring those skills to class with you. I've got two groups that are doing that. There's only one of me and I showed each group what to do at each station yesterday and the day before and I'm a little confused by when I show exactly what to do, then the next day I look at your work and there's nothing on the paper, there's no drawings, there's no writing. I need to hear from the pulley and the wedges group about what the problem is. Interpreter explained that 2 in the wedges group had TAG yesterday and the two that were present had finished but helped the other two complete the station. T - They need to make up TAG on their own time. If I had known that they were finished I would have had them change with the friction group. Some of the problems are that we don't understand what our responsibilities are. What about the pulley group? T talks individually with that group about the different parts of the assignment as other ss begin to clean up their stations.	7D 8E 13D 14D/E 16C/D

				0:50 S asked question about the correctness of his wheel and axle sheet. T talked him through. Which part makes the big circle - so that's the? S- wheel. T - For the pulley - The rope makes the wheel part. Another wheel and axle student wanted to know if they would have some time tomorrow. T said yes that she wasn't going to be in a big hurry and he would have time. T let groups know where they needed to move to tomorrow first thing and asked them to clean up their stations.	
	3		0:54	End of tape.	
10/17/03	4	T1	0:00	Ss return to class from their special area classes and sit at the stations they need to finish or a new station. Continuation of Simple machine station work.	
	4	A1	0:02	T announces that it's Ok to go ahead and get started, so the groups start working. I followed T to each station to observe interactions. 0:04 Wedge group - 2 girls and 1 boy The picture had a spring scale and ss were confused. The bungee cord attached to the wedge replaces the spring scale. T suggested that they turn the books so that the smooth side faces each other. Ss had measured the length of the cord - 1 foot. T- When the book moved what happened to the bungee cord? S- It got longer. T - But what happened after the book moved? S - the bungee cord returned to normal size. One s held one book, one s pulled the pulley, and one s lightly held the second book. They measured the stretch with measuring tape - 17 inches. S - it changed 5 inches. T asks them to write down the data on the back of their paper. T suggests they label the trial #, the wedge (A or B), the starting and ending length of the bungee cord, and the amount of stretch. T - How many trials do you think we should do to get results that match. Ss- 3. They measure the cord before it is stretched to make sure it is still 12 inches. This time it stretches 6 inches. T - I wonder what made it different from the first trial. Is there anything we can do to maybe control the conditions to be more accurate? S - make sure they are even. T - how. S - pushes the book to line up the books with the lines in the floor tiles. T - How about how far the books are apart? S - We can mark lines on the wedge showing where it hits the books. T - do those lines need to be the same every time? S - no; yes. T - would it be easier to pull the wedge when the books are closer to the top of the wedge or when the books are closer to the bottom of the wedge. Ss point toward the bottom. T - good. So why do we need the lines in the same place every time? S - to make it easier to pull; it takes different strengths at different parts of the wedge. T - so if you have the same setup each time you should get similar results. S- so should we do this one more time? T - I would suggest that you set it up more carefully and do it at least 3 more times, or at least until you are getting similar results. S- so for A and B and not C. T - Yes, good job scientists. 0:14 T goes to another group.	6D 7D 8E 10D 12E 13D 14D/E 15C

				Wedges group continues working on the station.	
	4		0:15	T gives some short explanations to the pulley group. T then does some more drilling at the lever station.	
	4		0:16	Friction station and wheel and axle station trade places. As soon as friction table takes a seat, they take out the paper from folder one and begin reading background information about friction. Ss do the same thing at the wheel and axle station. Ss at the lever station struggle with putting the board on the bolts of the fulcrum. Teacher helps them figure out how to adjust it.	
	4		0:19	S walks around with sanitizing liquid and squirts in each ss hand. Ss clean their hands before lunch.	
	4		0:20	Ss in wheel and axle group (3 boys) are taking turns reading their information sheet out loud to each other.	
	4		0:21	Break for lunch time. Stop tape.	
	4		0:21	Ss return from lunch and begin working at their stations again.	
	4		0:22	Inclined planes station completed their station.	
	4		0:23	Friction station - 2 girls; 2 boys (shaggy carpet, a block covered with sandpaper, a block with another rough surface, smooth styrofoam-like slick surface) The group was attempting to determine how to complete the station. Ss measure the bungee cord. 11 and a fourth. T - let's find an easier way to measure. If you go from the outside to the outside (of the bracket on the cord) it measures 10 inches. Make it easier on yourself. Why are we measuring the cord? S - because we are supposed to measure it before we use it. T - what's your idea for testing friction, what are you going to do? S- when you pull on the block see how far the cord stretches. T - you guys are pretty smart. S - I was watching the other group. T - that's Ok. That's called innovation. Show me how you are going to set it up. S - pulls the block on the carpet. T- what happens to the cord. S - it stretches and then it goes back down. T - so when would be the best time to start measuring? S - right before it starts moving. T - so if there was a way to stop it right before it starts moving, we could measure it, couldn't we? So what could we do? S - grab it. T what does the person do with the cord once the block stops moving. S - keep the cord still. T - asks each student to take a responsibility in the station. What is the manipulated variable, what are you comparing? S- to see which one can go faster. T - which one, what, the bungee cord, the block? S - points to carpet. T - and what do you call these, it starts with an s? Gives wait time and tells them surface. Predict the order that you think the easiest to the hardest. One S placed them in an order that he predicted. They chose a different bungee cord (9 inches) to work with.	
	4		0:30	Student from pulley group asked for some help. T - So what is the manipulated variable, remember it's the one you are contrasting/comparing? S -the friction of different... T - Surfaces,	

				different surfaces. What are you going to measure? S - the bungee cord. T - the amount the bungee cord stretches. 0:31 another group asks for help. T says she needs to go to pulleys first. S says they are finished. T tells them to write any other observations in their investigation notebook and then move on to inclined planes. T - and what does the amount of the stretch of the bungee cord tell you? S - the amount of effort. T - Good, how much effort or force you have to use to get the load to move. The more force you have to use. S - the more friction. T- and what are some of the controls. (involves another student). S - they have different surfaces. T- but what do they have in common? S - They are the same length. T- what else are we using that's the same? S - the bungee cord and the block. In a different area of the worksheet they need to write about the steps they are using.	
	4		0:34	T moves to pulley group. all groups are working well in their stations. Pulley group is testing a movable pulley	
	4		0:38	Lever station. They are looking at different types of levers. T - asks them what kind of lever they created. Ss- third. T - Are you sure? How can you tell? Gave wait time. T - By the location of the parts, look at your fact sheet. Where is the fulcrum on 3rd class levers? Ss looking at the chart. The fulcrum is at the end. The teacher walks them through. They attach one end of the board to the fulcrum and a large weight on the other side of the board as a load. The object is to see how much effort it takes to lift this.	
	4		0:45	Screw (at wheel and axle station) - I asked them what they were working on. We are trying to figure out which ones take more force. Which screwdrivers and which screws. Like the smallest one with the biggest screwdriver.	
	4		0:46	T working with lever group. T tried to understand their experimental setup and help them improve the design. T - on a 1st class lever does the fulcrum always have to be in the exact middle? Ss - no. T - that's right. The weights may not be accurate because they have been dropped and some sand has come out. T says her fulcrum contraption is not perfect but they can get the idea.	
	4	T2	0:48	T - tells students to clean up stations because it's time to go.	
	4		0:50	End of Tape/Class	
OVERALL COMBINED LESSON CODES					5E 9E11E 17E18E19D 20C21B22A

Ocean posters - one wall, periodic table of elements, clouds bulletin board, Scientific method bulletin board (one word and picture per poster - graph, predict, etc.).

Appendix K - STAM Analysis and Average Calculations

Appendix K.1 - Pre and Post STAM Analysis Records: Analysis summary

STAM Analysis Record Pre-Observations - Marie

	3/7/03					3/13/03				3/21/03					**Summary**
	Rev.	Intro to Matter	Managers	Gloop & comp.	Clos.	Rev.	ID pract.	P-dough/ comp.	Clos.	Song	Rev.	ID prac.	S-putty/ comp.	Clos.	
1	--	B	--	A	A	A	C	A	A	A	A	A	B	B	**A/B**
2	--	C	--	A	--	--	C	C	--	--	--	C	C	--	**C**
3	--	C	--	A	--	--	C	B	--	--	--	A	C	--	**B/C**
4	--	A	--	C	--	--	A	C	--	--	--	A	C	--	**A/C**
5	Review, discussion, activity, computer work, closure					Review, practice, activity, computer work, closure				Song, review, practice, activity, computer work, closure					**C**
6				✓				✓					✓		**B**
7	--	C	--	--	C	C	C	--	C	--	C	C	--	C	**C**
8	--	C	--	A	A	B	B	A	A	--	A	A	B	C	**A/B**
9		✓			✓	✓	✓		✓		✓	✓		✓	**C**
10		B			B	B	B		B		B	B		B	**B**
11															**C**
12															**A**
13	A	A	A	B	A	A	A	B	A	A	A	A	B	A	**A/B**
14	A	A	A	B	A	A	A	B	A	A	A	A	B	A	**A/B**
15		C													**A**
16															**C**
17	Tape, charts, lab material, computer					ID cards, lab mat., comp.				Guitar, ID cards, lab mat., comp.					**C/D**
18	Resources used for understanding & illustration														**C/D**
19															**B**
20															**A**
21	Room posters etc. - Matter; mixing and baking (for chemistry); human body; animals.; class managers chart, word chart; 6 computers; many living organisms (fish, bees, guinea pig, lizard)														**B**
22															**A**

STAM Analysis Record Post-Observations - Marie

	Day 1 - 1/7/04			Day 2 - 1/14/04			Day 3 - 1/21/04				**Summary**
	Rev. Plants & Roles	FP - story & intro	Activity	FP - transpar terminol	FP - descrip.	Activity a and b	Review	FP - transpar terminol	Activity a and b	Closure	
1	B	C	C	C	B	B	B	C	B	A	**B/C**
2	--	C	--	C	--	--	--	C	--	--	**C**
3	C	C	C	C	C	C	C	A	C	A	**C**
4	--	C	C	--	--	C	--	--	C	--	**C**
5	Rev., coop. learning, story, hands-on, computer			Lecture, hands-on, computer			Rev., hands-on, computer				**C**
6			✓			✓			✓		**B**
7	C	C	C	C			C				**C**
8	C	C		C	D	C	B	B	--	A	**B/C**
9	✓	✓		✓	✓		✓	✓		✓	**C**
10	B	B		B	B		B	B		B	**B**
11	C	C	--	C	--	--	C	C	--	--	**C**
12			✓			✓			✓		**C**
13		B	C	B	B	C	B	C	B		**B/C**
14			C			C			C		**C**
15		C	C			C		B			**C**
16											**C**
17	Lecture, Fast plant story and activity materials, computer program										**C**
18											**D**
19											**C**
20											**C**
21	Word wall, Fast Plant poster, T-made posters on growing instructions										**C**
22											**A**

STAM Analysis Record Pre-Observations - Tee Jay

	3/20/03			3/21/02				4/1/03			**Summary**
	Review	Demo	Reading	Water cups	Pyramid	Reading	Questions 5	Review	Display Board	Exit Ticket	
1	C	C	C	C	B	B	B	C	C	A	**B/C**
2	C	--	C	C	--	C	--	C	--	--	**C**
3	C	--	C	C	--	C	--	C	--	--	**C**
4	No mention of history; but used some hands-on activities										**B**
5	Demo, reading, discussion			Demo, reading, discuss., notes, bookwork				Review, notes, post-assessment			**C**
6		✓		✓	✓				✓		**C**
7	C	C	C	C	C	C	--	C	C	--	**C**
8	C	C	C	B	--	--	--	C	--	--	**C**
9	✓				✓		✓	✓	✓	✓	**C**
10	B				B		B	B	B	B	**B**
11											**C**
12	✓	✓			✓		✓		✓	✓	**C**
13	A	A	A	A	A	A	B	A	B	A	**A/B**
14	A	A	A	A	B	A	A	A	B	A	**A/B**
15	C	--	--	C	--	--	--	C	--	--	**C**
16											**C**
17	Tbook; bulletin board			Water demo; pyramid construction; tbook				Tbook; display board construction			**C**
18											**C**
19											**C**
20											**B**
21	Water Cycle bulletin board and non-science related displays										**B**
22											**B**

STAM Analysis Record Post-Observations - Tee Jay

	11/5/03				11/6/03					11/7/03				**Summary**
	Journal	Predict	Explore	Journal	Rev.	Debate	Discuss	Read	Write	Rev.	Read	Answer 2 ?s	Journal	
1	--	D	D	--	D	D	D	C	--	C	C	C	--	**C/D**
2	--	D	D	--	D	D	D	C	--	C	C	C	--	**C/D**
3	--	D	D	--	D	D	D	C	--	C	C	C	--	**C/D**
4	--	C	C	--	C	C	C	--	--	--	--	--	--	**C**
5	Journal writing, discussions, reading textbook, sifting dirt, debating, reviewing, answer questions from text													**D**
6			✓			✓								**D (many?)**
7	--	D	D	--	D	D	D	C	--	C	C	C	--	**C/D**
8	--	D	D	--	D	D	D	C	--	D	C	--	--	**D**
9		✓		✓	✓	✓	✓		✓	✓		✓	✓	**D**
10		C		C	D	D	D		B	B		B	B	**C**
11	D	D	D	D	D	D	D	C	D	C	C	C	--	**D**
12	✓	✓	✓	✓	✓				✓			✓	✓	**D**
13		C	C	C	C	C			C		C	C	C	**C**
14	D	D	D		D							D		**D**
15		C		C		C			C	C	C			**C**
16														**C**
17	Journal, dirt activity materials, Textbook													**B**
18														**C**
19														**B**
20	B	C	C	B	B	C	B	B	C	B	B	B	C	**B/C**
21	Store-bought posters: Writing as a process, presidents, American history; bulletin board about writing; Teacher-made posters: Focus questions for Language arts, reading, spelling; respect													**B**
22														**A**

STAM Analysis Record Pre-Observations - Daphne

	4/15/03			4/16/03		4/17/03 *(No videotape -T report of class)*				**Summary**
	Plastic Discussion & Vocabulary	Reading	Data collection & 3-2-1	Review of vocab and 3-2-1 responses	Reading and 4 questions	Vocab review	Animal data collection and disc.	Webquest	Closure	
1	B	--	--	B	--	?				**B**
2	C	--	--	C	--	?				**C**
3	A	A	A	A	A	?				**A**
4	C	--	C	C	--	?	B	?	?	**C**
5	Discussion	Ss read	Activity	Discuss.	Ss read	Discuss.	Discuss.	Activity	Discuss.	**C**
6			✓	✓			✓	✓		**B/C**
7	C	--	C	C	C	C	--	--	C	**C**
8	B	--	C	B	B	?				**B**
9	✓		✓	✓	✓	✓			✓	**C**
10	B		B	B	B	B	--	--	B	**B**
11	C	--	C	C	C	C	C	--	--	**C**
12			✓		✓		✓	✓		**C**
13	A	B	B	--	B	?				**B**
14	--	B	B	--	B	--	B	B	--	**B**
15	C	--	C	C	--	?				**C**
16										**C**
17	Jungle friends	Reading	data sheet	Magazine	gum/demos			Internet		**C**
18										**C**
19										**B**
20										**A**
21	Maps - world and continents, Happy B-day bulletin board, Time/money/weather chart/, math posters, word wall, Level I-III discipline, character counts posters, Metric system (t-made poster).									**B**
22										**A**

STAM Analysis Record Post-Observations Daphne

	10/8						10/9			10/10				**Summ**
	KWL	Obs bugs Cl	Group bugs	Discuss	Decide Exper	book	T/S plan exp	Exp	Teamwork -- conclusion	Review	Mealw book	WebQ -- share	New exp.	
1	--	D	D	D	D	C	D	D	D - D	C	B	C - C	--	**C/D**
2	--	D	D	D	--	C	C	D	--	C	C	C	--	**C/D**
3	--	--	--	D	D	--	D	D	--	C	C	C - C	--	**C/D**
4	C	D	D	D	D	--	D	D	- - D	C	C	C - C	C	**C/D**
5	Discussion, observations, reading						Experiment, discussion			Review, Webquest, discussion, journal				**D**
6		D	D		D		D	D				C - -		**D**
7	D	D	D	D	D	--	C/D	D	D - -	C	C	C - C	--	**C/D**
8	D	D	D	D	D	--	C/D	--	- - D	C	C	- - C	--	**C/D**
9	✓		✓	✓	✓		✓		✓ - ✓	✓		✓ - ✓	✓	**D**
10	C		C	C	D		C		C - C	B		B - B	D	**C**
11	D	--	--	D	D	--	D	--	D - C	C	--	- - C	D	**C/D**
12		✓	✓			✓	✓	✓	- - ✓			✓ - -	✓	**D/E**
13	--	--	--	C	D	--	B	--	- - -	C	--	C - -	--	**C**
14	--	D	D	--	--	--	--	D	D - -	--	--	C - -	--	**C/D**
15	--	D	D	C	--	--	C	--	- - C	D	--	- - C	--	**C/D**
16	C						E	C	E - C	C				**C/E**
17	Mealworms, magnifying glass, books						Experiment materials			Book and computers/internet				**D**
18														**D**
19														**C**
20	C	C	C	C	D	B	D	D	D - D	B	B	B- C	C	**C**
21	Teacher-made reading posters; word wall; Classroom managers; math set of posters; character counts posters; geography posters													**B**
22														**A**

STAM Analysis Record Pre-Observations - Shannon

	4/17/03			4/24/03				4/29/03		**Summary**
	Review	Presentations	Muscle Activity	Ball demo	Reaction time	Vocab book and notes	Ass. Steps of stimulus	Review	Read and discuss senses	
1	C	D	C	C	C	C	D	C	C	**C**
2	C	D	C	C	C	C	D	C	C/D	**C**
3	--	--	C	--	C	A	--	C	S	**B**
4	--	--	C	C	C	B	B	B	B	**B/C**
5	1 T-centered; 2- S-centered (writing & hands-on)			3 - T-centered; S - writing				2 T-centered		**C**
6		✓	✓	✓	✓					**C**
7	C	C	D	C	C	C	C	C	C	**C**
8	C	--	D	C	D	C	--	C	C	**C**
9	✓	✓					✓	✓		**C**
10	B	B					B	B		**B**
11	C		C		C			C	C	**C**
12		✓	✓			✓	✓			**C**
13	A	A	A	A	A	B	B	B	D	**A/B**
14	A	B	B	A	A	B	C	A	A	**A/B**
15	A	C	B	C	C	B	--	C	C	**B/C**
16										**C**
17	Mr. Bones, clips activity, textbook			Vocab. Books, textbook, demo materials				Textbook		**B**
18	C	C	D	C	C	D	D	C	C	**C/D**
19										**B**
20										**A**
21	Class Manger bulletin board, Reading vocabulary chart, Homework bulletin board									**B**
22										**A**

STAM Analysis Record Post-Observations - Shannon

	11/6/03				11/7/03			11/10/03				**Summary**
	Review	Reflec/ Refrac discuss	Mirror activity	Closure	Review	Light/ color activity	Closure discuss activity	Review	Read	Refl & absorp activity	Closure discuss	
1	C	C	D	C	B	D	C	C	C	D	C	**C/D**
2	C	C	D	C	C	C	C	C	C	C	C	**C**
3	C	C	C	C	C	D	C	C	C	C	C	**C**
4	C	C	D	C	--	D	D	C	C	D	C	**C/D**
5	Discussion; group work				Discussion; group work; demo			Discussion; group work				**D**
6		✓	✓			✓	✓			✓		**D**
7	C	C	D	C	C	D	C	C	C	D	D	**C/D**
8	C	C	D	D	C	C	C	C/D				**C/D**
9	✓		✓	✓	✓		✓	✓			✓	**D**
10	B		B	B	B		B	B			B	**B**
11	C	C	--	--	C	--	C	C	--	--	C	**C**
12		✓	✓	✓		✓				✓	✓	**D**
13	C	C	C	C	B	C	C	C	C	C	C	**C**
14			D			D				D		**D**
15		C		C	C	C	D			C		**C**
16												**C**
17	Slinky; textbook, mirrors, flashlights				Tbook; Saran Wrap; prism			Tbook; objects Saran Wrap				**D**
18	C	C	D	C	D	D	D	C	C	D	D	**C/D**
19												**B**
20												**C**
21	Teacher-made posters: Story chart (author, vocabulary, etc.), class rules. Store-bought posters: Multiplication chart, Birthdays, Helper Bulletin Board (Project Grad), Vine of Kindness (Project Grad), United States, Computer assignment											**B**
22	Simple Machine student -made posters (unique); pictures of students making graphs (in hall), Graphs made by groups of students regarding class statistics, Fabulous Fall work (individual student assignments posted), Great Wall of Ideas (Project Grad)											**D**

STAM Analysis Record Pre-Observations - Laura

	4/14/03		4/15/03			4/16/03			4/17.03		**Summary**
	Discussion First Law in seats	Ball activity - pairs/ gr. discussion	Ball activity - 2nd law Pairs/group	3rd law discussion and demos	Paired practice of 3 laws & disc.	Discuss energy	Paired practice and group discussion	Review energy w/ partner	Bldg Kinex cars	Closure	
1	D	D	D	D	D	C	D	D	D	C	**D**
2	D	E	E	D	E	D	E	E	D	--	**D/E**
3	D	E	D	D	E	D	D	D	E	--	**D**
4	D	E	E	C	E	D	D	E	E	--	**D/E**
5		✓	✓	✓	✓	✓		✓	✓		**E**
6		D	D	D	D	C	D	D	E	--	**D**
7	D	E	E	D	D	D	E	E	E	C	**D/E**
8	D	E	E	E	D	C	E	D	--	C	**D/E**
9	✓	✓	✓	✓	✓	✓(pre)	✓	✓	--	✓	**D/E**
10	D	E	E	D	E	C	D	D	--	B	**D/E**
11	E	E	E	E	E	E	E	E	E	--	**E**
12	✓	✓	✓	✓		✓	✓	✓			**D**
13		E	--	E	E	--	D	E	--	--	**E**
14	--	E	E	--	E	--	E	E	D/E	--	**E**
15	E	E	E	E	C	C	E	E	E	--	**E**
16	C	C	C	C	C	C	C	C	D	C	**C**
17	Multiple balls, balloons								K'nex		**D**
18											**D**
19		C	C	C	C		C	D	D		**C/D**
20											**C**
21	Scientific process bulletin board; weather charts/bulletin board; percent/decimal/fraction/equivalence chart										**B**
22	Student work is not posted on walls; however, teacher created a scrapbook of student pictures and work.										**D**

STAM Analysis Record Post-Observations - Laura

	10/7/03	10/10	10/16		10/17	**Summary**
	notes	Inspiration	Station work	Discussion	Station Work	
1	D	--	D	D	D	**D**
2	D	C/D	D	D	D	**D**
3	D	--	D	D	D	**D**
4	--	--	D	D	D	**D**
5	✓ (T-centered)	✓(T/S-centered)	✓ (S-centered)			**E**
6	--	C/D	D		D	**C/D**
7	C/D	D	D	--	D	**D**
8	E	D	E	--	E	**E**
9	✓ (self and T ?s)	✓ (T ?s)	✓ (T ?s, rubrics, journal, station sheets)			**E**
10	D	B	D	--	D	**D**
11	E	E (prior to class)	E	E	E	**E**
12	D	D	E	E	E	**D/E**
13	D	B	D	D	D	**D**
14	C	C	D & E (varies among groups)			**D**
15	C	A	C	--	C	**C**
16	C	C/D	C/D	C	C	**C/D**
17	Previous use of library books for notes	Computer lab	Station materials			**E**
18						**E**
19						**D**
20						**C**
21	Ocean posters; periodic table of elements; clouds bulletin board; scientific method bulletin board; daily activities board					**B**
22						**A**

Appendix K.2 - STAM Average calculations

Marie's Summary STAM Scores and Averages

Row	Pre Summary	Score	Post Summary	Score
1	**A/B**	1.5	**B/C**	2.5
2	**C**	3	**C**	3
3	**B/C**	2.5	**C**	3
4	**A/C**	2	**C**	3
Content Average		9/4=2.25		11.5/4=2.875
5	**C**	3	**C**	3
6	**B**	2	**B**	2
7	**C**	3	**C**	3
8	**A/B**	1.5	**B/C**	2.5
9	**C**	3	**C**	3
10	**B**	2	**B**	2
11	**C**	3	**C**	3
Teacher's Actions Average		17.5/7=2.50		18.5/7=2.64
12	**A**	1	**C**	3
13	**A/B**	1.5	**B/C**	2.5
14	**A/B**	1.5	**C**	3
15	**A**	1	**C**	3
16	**C**	3	**C**	3
Students' Actions Average		8/5=1.60		14.5/5=2.90
17	**C/D**	3.5	**C**	3
18	**C/D**	3.5	**D**	4
19	**B**	2	**C**	3
Resources Average		9/3=3.0		10/3=3.33
20	**A**	1	**C**	3
21	**B**	2	**C**	3
22	**A**	1	**A**	1
Environment Average		4/3=1.33		7/3=2.33
Total STAM Summary*		47.5/22=2.16		61.5/22=2.80

*Average of participant's scores on 22 rows.

Tee Jay's Summary STAM Scores and Averages

Row	Pre Summary	Score	Post Summary	Score
1	**B/C**	2.5	**C/D**	3.5
2	**C**	3	**C/D**	3.5
3	**C**	3	**C/D**	3.5
4	**B**	2	**C**	3
Content Average		10.5/4=2.625		13.5/4=3.375
5	**C**	3	**D**	4
6	**C**	3	**D (many?)**	4
7	**C**	3	**C/D**	3.5
8	**C**	3	**D**	4
9	**C**	3	**D**	4
10	**B**	2	**C**	3
11	**C**	3	**D**	4
Teacher's Actions Average		20/7=2.857		26.5/7=3.79
12	**C**	3	**D**	4
13	**A/B**	1.5	**C**	3
14	**A/B**	1.5	**D**	4
15	**C**	3	**C**	3
16	**C**	3	**C**	3
Students' Actions Average		12/5=2.40		17/5=3.40
17	**C**	3	**B**	2
18	**C**	3	**C**	3
19	**C**	3	**B**	2
Resources Average		9/3=3		7/3=2.33
20	**B**	2	**B/C**	2.5
21	**B**	2	**B**	2
22	**B**	2	**A**	1
Environment Average		6/3=2		5.5/3=1.83
Total STAM Summary*		57.5/22=2.61		69.5/22=3.16

*Average of participant's scores on 22 rows.

Daphne's Summary STAM Scores and Averages

Row	Pre Summary	Score	Post Summary	Score
1	**B**	2	**C/D**	3.5
2	**C**	3	**C/D**	3.5
3	**A**	1	**C/D**	3.5
4	**C**	3	**C/D**	3.5
Content Average		9/4=2.25		14/4=3.5
5	**C**	3	**D**	4
6	**B/C**	2.5	**D**	4
7	**C**	3	**C/D**	3.5
8	**B**	2	**C/D**	3.5
9	**C**	3	**D**	4
10	**B**	2	**C**	3
11	**C**	3	**C/D**	3.5
Teacher's Actions Average		18.5/7=2.64		25.5/7=3.64
12	**C**	3	**D/E**	4.5
13	**B**	2	**C**	3
14	**B**	2	**C/D**	3.5
15	**C**	3	**C/D**	3.5
16	**C**	3	**C/E**	4
Students' Actions Average		13/5=2.60		18.5/5=3.70
17	**C**	3	**D**	4
18	**C**	3	**D**	4
19	**B**	2	**C**	3
Resources Average		8/3=2.67		11/3=3.67
20	**A**	1	**C**	3
21	**B**	2	**B**	2
22	**A**	1	**A**	1
Environment Average		4/3=1.33		6/3=2.0
Total STAM Summary*		52.5/22=2.39		75/22=3.41

*Average of participant's scores on 22 rows.

Shannon's Summary STAM Scores and Averages

Row	Pre Summary	Score	Post Summary	Score
1	**C**	3	**C/D**	3.5
2	**C**	3	**C**	3
3	**B**	2	**C**	3
4	**B/C**	2.5	**C/D**	3.5
Content Average		10.5/4=2.625		13/4=3.25
5	**C**	3	**D**	4
6	**C**	3	**D**	4
7	**C**	3	**C/D**	3.5
8	**C**	3	**C/D**	3.5
9	**C**	3	**D**	4
10	**B**	2	**B**	2
11	**C**	3	**C**	3
Teacher's Actions Average		20/7=2.86		24/7=3.43
12	**C**	3	**D**	4
13	**A/B**	1.5	**C**	3
14	**A/B**	1.5	**D**	4
15	**B/C**	2.5	**C**	3
16	**C**	3	**C**	3
Students' Actions Average		11.5/5=2.30		17/5=3.40
17	**B**	2	**D**	4
18	**C/D**	3.5	**C/D**	3.5
19	**B**	2	**B**	2
Resources Average		7.5/3=2.50		9.5/3=3.17
20	**A**	1	**C**	3
21	**B**	2	**B**	2
22	**A**	1	**D**	4
Environment Average		4/3=1.33		9/3=3.0
Total STAM Summary*		53.5/22=2.43		72.5/22=3.30

*Average of participant's scores on 22 rows.

Laura's Summary STAM Scores and Averages

Row	Pre Summary	Score	Post Summary	Score
1	**D**	4	**D**	4
2	**D/E**	4.5	**D**	4
3	**D**	4	**D**	4
4	**D/E**	4.5	**D**	4
Content Average		17/4=4.25		16/4=4.0
5	**E**	5	**E**	5
6	**D**	4	**C/D**	3.5
7	**D/E**	4.5	**D**	4
8	**D/E**	4.5	**E**	5
9	**D/E**	4.5	**E**	5
10	**D/E**	4.5	**D**	4
11	**E**	5	**E**	5
Teacher's Actions Average		32/7=4.57		31.5/7=4.50
12	**D**	4	**D/E**	4.5
13	**E**	5	**D**	4
14	**E**	5	**D**	4
15	**E**	5	**C**	3
16	**C**	3	**C/D**	3.5
Students' Actions Average		22/5=4.40		19/5=3.80
17	**D**	4	**E**	5
18	**D**	4	**E**	5
19	**C/D**	3.5	**D**	4
Resources Average		11.5/3=3.83		14/3=4.67
20	**C**	3	**C**	3
21	**B**	2	**B**	2
22	**D**	4	**A**	1
Environment Average		9/3=3.0		6/3=2.0
Total STAM Summary*		91.5/22=4.16		86.5/22=3.93

*Average of participant's scores on 22 rows.

VITA

Leslie Ann Suters was born in Cookeville, Tennessee on March 15, 1971. She attended the public schools of Knoxville, Tennessee where she graduated from Farragut High School in 1989. She pursued a teaching degree from the University of Tennessee, Knoxville and received her Bachelor of Science degree in Pre-Teaching with a Science Concentration in 1993 and her Master of Science degree in Curriculum and Instruction in 1994. From 1995 to 2000 she was employed by the Knox County school district at Northwest Middle School and taught 6^{th}-8^{th} grade health, 6^{th} grade math, and 7^{th} grade life science. She moved to Talbott, Tennessee during the 1999-2000 school year and transferred to the Jefferson County School district where she taught 4^{th} grade at White Pine school during the 2000-2001 school year. In 2001, 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 as a graduate teaching and research assistant for three years. Her doctoral degree in Education was conferred in May 2004.