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THE EFFECT OF TEACHERS' INSTRUCTIONAL STYLE ON THE MOTIVATION AND ATTITUDES OF AT-RISK SCIENCE STUDENTS ATTENDING ALTERNATIVE EDUCATION PROGRAMS

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DEDICATION

This dissertation is dedicated to my sons, Maurice Jr. and Matthew, who transitioned from young boys to a teenager and a pre-teen while I was enrolled in graduate school. My wish is that you accomplish your dreams and career aspirations as I am accomplishing my dreams and career aspirations.

ACKNOWLEDGEMENTS

I can do all things through Christ who strengthens me.

Philippians 4:13(New King James Version)

Thank you to my family, friends, colleagues, and advisor for encouraging and supporting me through graduate school and the dissertation process.

Thank you to the four alternative education teachers who participated in this study. As a former alternative education teacher, I understand how difficult it is to allow a stranger to observe your teaching practices. Regardless of your apprehensions, you warmly welcomed me into your classrooms and allowed me to conduct my research. Thus, allowing me to share your vision of alternative education, your stories, and your students' stories.

Thank you, Lord, for ordering my steps. Throughout this journey, I have learned that your will and your way will be done.

ABSTRACT

Despite a steady improvement in overall graduation rates since the 1960s, many students in the United States continue to leave school without a diploma (Balfanz, Bridgeland, Moore, & Fox, 2010). In an effort to educate children who present increased risks for dropping out of school, alternative schools are mandated by all states. Typically, high-risk youth who attend these types of programs have been exposed to negative social and environmental risk factors throughout their lives stemming from problems associated with poverty, family adversity, inadequate parental monitoring, and/or physical and emotional trauma (Guerin & Denti, 1999; Mclntyre, 1993; Waldie & Spreen, 1993). Due to the negative social and environmental risk factors, at-risk students present challenges to teachers regarding instruction. Teachers need to incorporate effective instructional strategies which will motivate students to learn science and improve students' attitudes toward science.

This mixed-methods study examined the perceptions of four alternative education science teachers and their students. Teachers' beliefs about students learning were examined to determine how their beliefs affected their pedagogy. Students' perception of the science classroom was investigated in relation to teachers' instructional style. Teachers' instructional styles were analyzed to determine how their pedagogy affected students' motivation to learn science and attitudes toward science.

Key factors which led to motivation and improved attitudes of at-risk science students were caring teacher-student relationships, relevancy of the learning, and the incorporation of inquiry based activities. Results show the need for reformed based instruction at the pre-service levels to prepare future educators to effectively teach all students, including the at-risk population. Findings from this research may encourage principals to provide professional development for teachers focused on caring teacher-student relationships, relevancy of learning, and incorporation of inquiry based activities.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

CLES	Constructivist Learning Environment Survey
EQUIP	Electronic Quality of Protocol Scale
PSTE	Personal Science Teaching Efficacy Beliefs
SAI II	Scientific Attitudes Inventory
SMQ	Science Motivation Questionnaire
STEBI-A	Science Teacher Efficacy Beliefs Instrument for In-service Teachers
STOE	Science Teaching Outcome Expectancy
TSES	Bandura’s Instrument Teacher Self-Efficacy Scale

CHAPTER 1

INTRODUCTION OF AT-RISK SCIENCE STUDENTS ATTENDING ALTERNATIVE EDUCATION PROGRAMS

At-risk Students

Researchers have been documenting and analyzing for numerous years the ways in which different "at-risk" populations of students continually fall through the cracks of the traditional American system of schooling (Ogbu, 1978; Oakes, Gamoran and Page, 1992; Stricklank and Ascher, 1992). Students at-risk are individuals who for a variety of reasons have a high frequency of dropping out of school prior to obtaining a high school diploma. To prevent at-risk students from dropping out of school completely, alternative education programs were created to meet the needs of students who were not being fulfilled by traditional schools. In comparison to students who attend traditional schools, students who attend alternative schools have higher incidences of substance abuse, depression, suicide attempts, sexual activity, and pregnancy. They are more likely to have been physically or sexually abused or witnessed abuse within their families. At- risk students more often come from low-income families, are members of ethnic minorities, and receive less educational support at home (Eckstrom et. al., 1986). Such students also are more likely than their peers not to graduate if they lack intrinsic motivation and possess low self-efficacy and low self-esteem. Additionally, students at-risk are difficult to engage academically (Tobias, 1992), have behavioral problems in school (Jimerson, Egeland, Sroufe, & Carlson, 2000), have been retained a grade (Jimerson, Anderson, &

Whipple, 2002), and work during normal school hours (Karpinski, Neubert, & Graham, 1992).

Motivation to Learn Science

Student motivation is a significant challenge encountered by virtually every high school teacher, but it is essential to engage students in achievement-oriented goal behaviors that lead to success in school (Pintrich, Conley, & Kempler, 2003; Skollingsberg, 2003; Wiseman & Hunt,2001). Research has shown that increased motivation leads to improvement in cognitive and behavioral engagement, ultimately resulting in conceptual understanding (Patrick & Yoon 2004; Pintrich & Schunk, 2002; Theobald, 2006). Too many students enter the science classroom with preconceived ideas that the subject is boring and irrelevant to their world (Pickens & Eick, 2009). Consequently, many students are unmotivated to learn science.

Students' Attitudes Toward Science

In science education, an enduring problem is that student attitudes toward science learning become more negative as students progress through K-12 grades and between the beginning and end of the school year while enrolled in science courses (Butler, 1999; Koballa, 1995; Yager & Penick, 1986). More specifically, students' attitudes toward science in high school is moderately low (Simpson & Oliver, 1985), and there is a decline in attitude toward science during middle or high school (Atwater, Wiggins, & Gardner, 1995; Welch, 1984; Ormerod & Duckworth, 1975; Randall, 1975; Simpson & Oliver, 1985,Ayers & Price, 1985; Bohardt, 1975; Cannon & Simpson, 1985; Disigner & Mayer, 1974; Haladyna & Shaughnessy, 1982; Hill, Atwater, &Wiggins, 1995; Hofstein 1990 ; Welch, 1984; Ormerod & Duckworth, 1975; Randall, 1975; Simpson & Oliver, 1985.)

Previous studies have revealed, however, that while relatively negative feelings of students are usually associated with more traditional approaches to science instruction (Lord, 1997; Shepardson & Pizzini, 1993), their perceptions of science classrooms as constructivist are correlated positively to student attitudes (Aldridge et al.,2000; Fisher & Kim, 1999; Hand et al., 1997). It is believed that science teachers who create constructivist learning environments will improve students' attitudes toward science and increase students' motivation to learn science.

In this dissertation study, I investigated how the instructional style of alternative education science teachers motivated their students to learn science and impacted students' attitudes to learn science. This research provides a picture of teaching practices in alternative education biology classrooms. Through this research, I hope to provide information on alternative education science programs from the perspective of students and their teachers.

Purpose

During the time the research was conducted, I was employed as a science teacher at an alternative education high school for at-risk youth in Northern California. Even though I taught science for twelve years prior to teaching at the alternative school, was enrolled in a doctoral program in secondary education, and attended numerous content and pedagogical workshops, I experienced difficulty engaging my at-risk students.

The principals of several alternative education schools in Northern California created a science consortium which allowed science teachers an opportunity to share ideas, strategies, and lessons. During one of these meetings, we began discussing our lack of science materials and equipment, the incorporation of inquiry based activities, and effective strategies to increase the motivation of our students. The struggle I experienced in the classroom and the conversations which occurred with other alternative education science teachers inspired me to investigate how students' attitudes toward science and motivation to learn science were related to their teachers' pedagogy.

I emailed several alternative education biology teachers in the Northern California area explaining that I was completing a dissertation pertaining to teachers' instructional style and was interested in conducting a teacher interview, several classroom observations, and student focus group interviews. Four teachers replied positively and welcomed me into their classrooms to conduct the research. Through teacher interviews, teacher questionnaires, classroom observations, focus groups, and student questionnaires, I learned how students' attitudes toward science and motivation to learn science are related to teachers' pedagogy. This dissertation was done in an attempt to discover which instructional strategies motivate students to learn science and improve students' attitudes toward science. The dissertation led to a greater understanding of science students who attend alternative education programs and science teachers employed by alternative education programs.

Research Questions

The purpose of this study was to understand the instructional style of four alternative education high school biology teachers and how their instructional styles affected the motivation and attitudes of their students to learn science. This research will provide new information on the motivation of at-risk students to learn science and the attitudes of at-risk students toward science. It will also provide evidence of the amount of inquiry instruction in alternative education science classrooms.

This study addresses the following research questions:

1. How do teachers' beliefs about student learning relate to their pedagogy?
2. How is students' motivation to learn science influenced by the teacher's pedagogy?
3. How are students' attitudes to learn science influenced by the teacher's pedagogy?

The study was conducted with teachers employed at alternative education high schools and their students; therefore, the results cannot be generalized or applied to all science teachers and all science students. Additionally, the participants were employed and attended alternative education high schools in Northern California; therefore, the results cannot be generalized or applied to science teachers employed at alternative high schools in other areas or to science students attending alternative education high schools in other areas.

Definitions

<u>At-Risk Students:</u> An "at-risk" student is a student who is likely to fail at school and drop out before high school graduation.

<u>Alternative Education School</u>: The Common Core of Data, the U.S. Department of Education's primary database on public elementary and secondary education, defines an alternative education school as "a public elementary/secondary school that addresses needs of students that typically cannot be met in a regular school, provides nontraditional education, serves as an adjunct to a regular school, or falls outside the categories of regular, special education or vocational education" (U.S. Department of Education 2002, Table 2, p. 14).

Traditional (Comprehensive) High School: Schools instruct students in grades ninth through twelfth whose curriculum is primarily college preparatory.

Self-Efficacy**:** “Beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3).

Teaching Efficacy: “The extent to which teachers believe that they have the capacity to affect student performance” (Ashton, 1984, p. 28).

Inquiry: “Inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating results. Inquiry requires identifications of assumptions, use of critical and logical thinking, and consideration of alternative explanations” (NSES, NRC, 1996, p. 23).

CHAPTER 2

A REVIEW OF THE LITERATURE RELATED TO THE MOTIVATION AND ATTITUDES OF ALTERNATIVE EDUCATION SCIENCE STUDENTS

Teacher Beliefs

According to Bandura (1986), an individual's decisions throughout his/her life are strongly influenced by his/her beliefs. Likewise, Pajares (1992) asserts that beliefs are ‘‘the best indicators of the decisions that individuals make throughout their lives’’ (p. 307). Teacher beliefs offer researchers a window through which to examine teachers' decision-making processes and instructional practices; in some cases the efficacy of the instructional practices can also be determined (Nespor, 1987; Pajares, 1992). Richardson (1997) found that teacher beliefs largely influence classroom practices and may act as filters that bias those practices.

Two broad categories of teachers' educational beliefs have been recognized in the literature (Sang, Valcke, van Braak, & Tondeur, 2009; Woolley, Benjamin, & Woolley, 2004). According to Woolley et al. (2004), traditional teaching beliefs, reflect teacher-centered approaches to teaching and learning, and constructivist teaching beliefs reflect student-centered approaches to teaching and learning. Traditional teaching beliefs, also known as teacher-centered (Bramald, Hardman, & Leat, 1995) or transmissive beliefs (Sang et al., 2009), are adopted by those teachers who concentrate on knowledge transmission, devise well-organized teaching plans, and embrace step-by-step teaching methods (Sang et al., 2012). Meanwhile, constructivist beliefs are also known as progressive beliefs or student-centered approaches (Bramald et al., 1995) and are often regarded as beliefs that support student learning (Samuelowicz & Bain, 1992) and provide a constructivist philosophy of learning (Bramald et al., 1995). Teachers who focus on constructive and progressive teaching and learning processes adopt constructivist beliefs (Sang et al., 2012).

Self-efficacy

Research on teacher efficacy beliefs is grounded in Bandura's social cognitive theory and his construct of self-efficacy (Bandura, 1977). According to Nichols & Utesch (1998), self-efficacy pertains to an individual's personal evaluation or confidence in his or her performance capability on a specific task. Bandura (1997) defined self-efficacy as, "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). Students with high self-efficacy willingly approach learning activities, expend effort to achieve goals, persist in the face of challenge, and use strategies effectively (Schunk, 1991). Conversely, learners with low self-efficacy avoid challenge, expend little effort and give up, and believe they are not in control of their learning (Schunk, 1991). Bandura (1986) argued that an individual's self-efficacy beliefs influenced their motivation in several ways: individuals with low self-efficacy tend to avoid activities they believe surpass their capabilities and, thus, consistently select easier tasks where the chances for success are greater; and the amount of effort that an individual invests in an activity and the level of persistence at difficult task is related to self-efficacy.

Guskey & Passaro (1994) defined teacher self-efficacy as a teacher's perceived capability to impart knowledge and to influence student behavior, even that of unmotivated or challenging students. Teachers' self-efficacy has been linked to their behavior in the classroom and the implementation of instructional change (Ashton & Webb, 1986; Guskey, 1986; Hanely, Wang, Keli, & Zoffel, 2007; McKinney, Sexton, & Meyerson, 1999; Timperely & Phillips, 2003). A teacher's sense of self-efficacy has been consistently recognized as an important attribute of effective teaching and has been positively correlated to teacher and student outcomes (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998), such as students' self-efficacy beliefs and student engagement, motivation, and achievement (Anderson, Greene, & Loewen, 1988; Midgley, Feldlaufer, & Eccles, 1989; Ross, 1992; Shahid & Thompson, 2001). Research has shown that teachers with high levels of self-efficacy work longer with students that struggle, recognize student errors, and attempt new teaching methods that support students (Gibson & Dembo, 1984; Ashton &Webb, 1986; Guskey, 1988). Czernaik (1990) found that highly efficacious teachers were more likely to use "reform-based" teaching method such as inquiry-based and student-centered approaches, while teachers with low levels of self-efficacy used more teacher-directed methods, such as lecturing and textbook reading.

Bandura's theory of self-efficacy is composed of two expectancies, self-efficacy and outcome efficacy. Self-efficacy expectation provides individuals a way to decide whether they have the ability to perform the required task at the desired level of competency, while outcome expectancy provides individuals a way to decide if they have accomplished a task at a desired level (Tschannen-Moran, et. al., 1998). Researchers have used Bandura's theory in the field of education in order to study teacher self-efficacy. Two dimensions of teacher efficacy have consistently been found independent measures: personal teaching efficacy and general teaching efficacy, sometimes referred to as outcome efficacy (Woolfolk-Hoy & Burke-Spero, 2005). Swackhamer, Koellner, Basile, and Kimbrough (2009) defined personal teacher efficacy as a teacher's belief in his or her skills and abilities to positively impact student achievement, while general (outcome) teaching efficacy has been defined as a teacher's belief that the educational system can work for all students, regardless of outside influences such as socio-economic status and parental influence.

Students' Attitudes toward Science

The key challenges facing the field of science education are recruiting, educating, and retaining students in the field of the sciences, technology, engineering, and mathematics (Welch, 2010). In 1999, among 3,540,800 persons employed in science and engineering occupations, only 1,032,100 had Master degrees and 484,100 had earned Doctorate degrees (Wilkinson, p. 2). In a report from the Merrill Advanced Studies Center, Ortega stated that "the fundamental problem is the declining percentage of students in science, technology, engineering, and mathematics (STEM) graduate programs, especially at the doctoral level" (Ortega, 2003). Educators must improve students' attitudes toward science and mathematics to enable students to pursue careers in the field of the sciences, technology, engineering, and mathematics.

Attitude has been defined differently by various researchers. Koballa and Crawley (1985) defined attitude as "general and enduring positive or negative feelings" (p.223). Koballa (1995) and Simpson et al. (1994) defined attitude as the favorable or unfavorable response to things, people, places, events or ideas. Adolpe (2002) and

Mueller (1986) described attitude as a non-observable psychological entity, which can only be deduced from a manifested behavior.

Several researchers have described attitudes in regards to students' attitudes toward science. Gardner (1975) defined attitude towards science as, "[l]earned predisposition to evaluate…objects, people, actions, situations or propositions involved in learning science" (p. 2). In most studies, the term "attitudes" is used to refer to the intrinsic values or interests of the students toward science and mathematics (Dethlefs, 2002). Students' attitude toward science refers to the opinions of students in positive or negative responses about science (Pruekpramool, Phonphok, White, &. Musikul, 2011). Additionally, students' attitude toward science refer specifically to whether a person likes or dislikes science based on his or her prior knowledge and past experiences including his or her feelings about the importance of science (Oliver & Simpson, 1988; Richard & Foy, 1997; Salta & Tzougraki,2004).

Concerns about attitude towards science are not new (Osborne, Simon & Collins, 2003) and students' interest in the fields of science, mathematics, and engineering is a major concern for science educators. According to TIMSS (1999) and the Ministry of Education (2009) generating positive attitude towards science among students is an important goal of science education. Project 2061 suggests "science education should contribute to …the development in young people of positive attitudes toward learning science" (American Association for the Advancement of Science (AAAS), 1990, p. 184). Similarly the endorsement of a positive attitude toward science has remained one of an important aim of the curriculum at school level (Aiken & Aiken, 1969; Koballa, 1988; Laforgia, 1988).

The importance of studying attitudes is well established because holding positive attitudes has positive relationship with increased enrolment in science courses, science achievement and interest in scientific careers (Carey & Shavelson, 1988). As a result, science educators have invested significant efforts into studying students' attitudes towards science in recent years (Cakmakci, Sevindik, & Pektas, 2011; Jenkins & Nelson, 2005; Koballa & Glynn, 2007; Osborne & Collins, 2001; Reiss, 2004). This increasing interest in studying students' attitudes towards science is based on the assumption that there is some level of positive correlation between students' positive attitudes towards science and their achievement in science (Koballa & Glynn, 2007; Laforgia, 1988; Shrigley, Koballa & Simpson, 1988), willingness to take advanced science courses, and desire to pursue science related careers post-secondary education (Baker, 1985; Butler, 1999; Hidi, Renninger, & Krapp, 2004; Osborne & Collins, 2001).

Science educators have studied students' attitudes towards science through multiple perspectives and in different contexts (e.g. high school and college) (Osborne, Simon, & Collins, 2003). Scholars have researched the difference between male and female students' attitudes towards science, the influence of instruction on students' attitudes towards science (Altinok & Un-Acikgoz, 2006; Cavallo & Laubach, 2001; Kaya & Geban, 2011), and the impact of curriculum on students' attitudes towards science (Lyons, 2006; Millar & Osborne, 1998; Osborne & Collins, 2001).

Research indicated that establishing an early positive attitude toward science is an essential element to science achievement (Tuan, Chin, & Shieh 2005). The students having positive attitudes towards learning science are more expected to have planning to engage in future learning behaviors in science subjects (Norwich & Duncan, 1990).

Attitudes about science are an indicator about quality of experiences in science and enjoyment of learning science (Lips, 1995; Raizen & Jones 1985). Additionally, student attitude toward science has been shown to correlate with achievement in the science classroom (Germann, 1988; Napier & Riley, 1985). According to Parker and Gerber (2000), attitudes, feelings, or perceptions of science are recognized as important for science achievement and for selection of science-related careers by students. Moreover, science attitudes were found to have a positive correlation with science achievement and participation in advanced science courses (Lee & Burkam, 1996; Simpson & Oliver, 1990; Weinburgh, 1993).

Science educators have noted a decline in students' attitudes toward science during the last thirty years. A national study, examining trends in undergraduate education, reveal a steady decline in student interest in the physical sciences and mathematics (Astin, 1997). Researchers have reported declines in attitudes toward science among students of all ability levels during middle or high school (Atwater, Wiggins, & Gardner, 1995; Ayers & Price, 1985; Bohardt, 1975; Cannon & Simpson, 1985; Disigner & Mayer, 1974; Haladyna & Shaughnessy, 1982; Hill, Atwater, &Wiggins, 1995; Hofstein & Welch, 1984; Ormerod & Duckworth, 1975; Randall, 1975; Simpson & Oliver, 1985, 1990). More specifically, the greatest declines in attitudes have been measured among "average" students as opposed to high or low ability (Atwater & Simpson, 1984; Cannon & Simpson, 1985; Simpson & Oliver, 1985, 1990; Simpson & Troost, 1982; Talton & Simpson, 1985), girls opposed to boys (Koballa, 1993), and those students with higher initial attitudes toward science at the beginning of middle school as opposed to those students with lower initial attitudes (Hill, Atwater, & Wiggins, 1995).

Female, African-American, and Hispanic students appear to have lower level of interest in the sciences than do male, Asian and Caucasian students (National Science Board, 2002). Research conducted by Pell and Jarvis (2001) found that when students hold negative attitudes toward science by age 12, they may avoid science classes in their later education and possibly not consider science careers upon graduation. According to Hornung (1987), lack of student enthusiasm, interest, or motivation in science contributed to reduced participation in science classes and to shortages of scientists and technologists in industry.

Several factors have led to the decline of students' attitudes toward science during the last thirty years. Students' attitudes toward science gradually declined from the 6th to 10th grade because of three factors: classroom environment, content load, and teaching strategies (Cokadar & Kulce, 2008). Osborne (2003) summarized the factors that affect students' attitudes towards science which include gender, classroom or teacher factors, instructional strategies, and students' beliefs and perceptions about science.

Studies exploring the relationship between curriculum and classroom instruction and students' attitudes towards science have established a positive relationship between the form of curriculum and instruction used in the classroom and the type of attitudes held by students (Aydeniz & Kaya, 2012). Tien, Roth, and Kampmeier (2002) found that student-centered learning with peer-led teams improved performance, retention, and attitudes about science. In studying students' attitudes toward science, researchers attribute constructivist learning environments which incorporate hands-on investigations and inquiry to improving students' attitudes toward science. Dethlefs (2000) conducted a study on the relationship of constructivist learning to students' attitudes and achievement in high school science and mathematics. He found the following results: constructivist learning environments are positively associated with student attitudes in high school biology and algebra; deeper cognitive processing strategies were present when students were allowed to exercise more control in their learning activities; students' enrollment in future elective classes was predicted as a result of their attitudes; and there is a strong relationship between cooperative group-work and students' interest in school.

Cavallo and Laubach (2001) investigated the impact of instruction on high school students' attitudes towards science by analyzing their enrollment decisions in elective science courses. They compared the attitudes of two groups of students who were taught by two different instructional methods: high pragmatic/high inquiry methods and low pragmatic/low inquiry methods. Their results indicated that students who were enrolled in high inquiry classrooms developed more positive attitudes towards science than those who were enrolled in low inquiry classrooms. Furthermore, they found that significantly more females in high inquiry classrooms showed commitment to taking advanced science courses than the females who were enrolled in low-inquiry classrooms. In their conclusion, Cavallo and Laubach (2001) stated that the learning cycle model of teaching (high inquiry) leads to positive attitudes towards science among students and enhances students' persistence in science learning. The study of Foley & McPhee (2008) revealed that students enjoyed learning science when they had opportunities to participate in hands-on activities. Students' attitudes toward science improve when they enjoy learning science.

Motivation

Motivation is a complex psychological concept that attempts to explain behavior and the effort at different activities (Cavaş, 2011; Watters & Ginns, 2000). Motivational literature uses many definitions to explain the concept of motivation. According to Brophy (2004), motivation is a theoretical concept that is used to explain beginning, direction, force and insistence of goal-oriented behavior. Ainley (2004) makes a definition related to motivation that it is about "energy, direction, the reasons for our behaviors, and what we do and why" (p. 2). Başdaş (2007) used motivation in the meaning of mobilizing effort and endeavor. According to Palmer (2005), motivation can be applied to any process that activates and maintains learning behavior. Additionally, Barlia (1999) stated that motivation is a vital educational variable promoting both new learning and performance of previously learned skills, strategies, and behaviors.

According to self-determination theory, when people are motivated, they intend to accomplish something and undertake goal-oriented behavior to do so (Sevinic, Ozmen, & Yigit, 2011). Behaviors revealed by motivated people may be either self-determined or controlled (Brophy, 2004; Deci, Vallerand, Pelletier & Ryan, 1991). To the extent that behaviors are self-determined, they are experienced as freely chosen and emanating from one's self (Sevinic, Ozmen, & Yigit, 2011). In the first part of self-determination theory, intrinsic motivation refers to doing an activity for itself and to the pleasure and satisfaction derived from participation (Cokley, Bernard, Cunningham & Motoike, 2001; Karsenti & Thibert, 1996; Vallerand, Pelletier, Blais, Briere, Senecal & Vallieres, 1992). In the second part of self-determination theory, extrinsic motivation focuses on external rewards such as the desire to obtain high grades and complete the program (Watters &

Ginns, 2000). Conversely, Miserandino (1996) defined extrinsic motivation as a behavior which is made to receive a reward or to avoid punishment. In the third part of the self-determination theory, amotivational syndrome occurs when individuals perceive their behaviors do not result in a certain outcome (Cokley et al., 2001). When individuals are unmotivated, they believe that their behaviors are the results of forces out of their control (Vallerand et al., 1992).

Motivation is considered one of the most significant determinants of students' success or failure in the classroom (Hidi & Harackiewicz, 2000; Reeve, 1996; Ryan & Connell, 1989) and has been examined by many researchers. Researchers have investigated how different factors influence motivation such as gender (Akbaş & Kan, 2007; Azizoğlu & Çetin, 2009; Bolat, 2007; Debacker & Nelson, 2001; Yılmaz & Çavaş, 2007), class level (Akbaş & Kan, 2007; Bolat, 2007; Çakmak et al., 2008), parental education level (Bolat, 2007; Davis-Kean, 2005; Dubow, Boxer & Huesmann, 2009), academic success (Akbaş & Kan, 2007; Altun, 2009; Patrick, Kpanghan & Chibueze, 2007), participating in laboratory activities (Gagne & Deci, 2005; Hofstein & Lunetta, 2003), taking private courses (Bolat, 2007), and utilizing the internet (Bassili, 2008; Ng & Gunstone, 2002; Tekinarslan, 2009; Wang & Reeves, 2007). Studies have shown that active involvement in learning activities is more motivating than passive involvement (Zahorik, 1996). In addition, student control and responsibility are also associated with increased motivation, which translates into increased learning and retention of information (Lepper & Hodell, 1989; Eggen & Kauchak, 2001).

Although motivational research indicates that increased student motivation leads to increased student learning, teachers find motivating students to learn extremely difficult. Student motivation is a significant challenge encountered by virtually every high school teacher, but it is essential to engage students in achievement-oriented goal behaviors that lead to success in school (Pintrich, Conley,& Kempler, 2003; Skollingsberg, 2003; Wiseman & Hunt, 2001). Students considered at-risk present even greater challenges for high school teachers to motivate. Several studies have found that at-risk students tend to have low achievement motivation, low efficacy beliefs, low expectations for success, and express few intrinsic desires to succeed by earning good grades (Huang &Waxman, 1996; Nunn & Parish, 1992; Strahan, 1988).

Research has shown that increased motivation leads to improvement in cognitive and behavioral engagement, ultimately resulting in conceptual understanding (Patrick & Yoon, 2004; Pintrich & Schunk, 2002; Theobald, 2006). There have been many studies exploring the effect of students' motivation on learning and teaching and revealing that many factors may affect students' motivation (Ames, 1992; Hanrahan, 1998; Palmer, 2005). Self-perceptions of ability, effort, task value, self-efficacy, test anxiety, self-regulated learning, task orientation, and learning strategies are some of the factors that may affect students' motivation (Brophy, 1998; Cavaş, 2011; Garcia, 1995; Garcia, & Pintrich, 1995; Nolen & Haladyna, 1989; Pintrich & Schunk, 1996).

Bolat (2007) defined motivation towards science learning as a desire of science learning. This concept is very important because students' motivation plays a crucial role in science learning, such as the conceptual change process, critical thinking process, and scientific process skills (Lee & Brophy, 1996). According to Cavas (2011), motivation to learn science promotes student construction of their conceptual understanding of science. In the literature, there have been reported numerous factors affecting students' motivation towards science learning (Sevinc, Ozmen, & Yigit, 2011). Results of research conducted by Güvercin, Tekkaya, and Sungur (2010) showed that students' motivation towards science learning declined as the grade level increased and girls had a higher motivation towards science learning than boys.

When educators fail to convey to students what science truly is, they dampen the students' natural curiosity and stifle their motivation (Genoni, 1995). Research has indicated that if teachers can tap into the natural curiosity of students by scientific inquiry, students not only will be more motivated to learn, but also will gain the skills needed to harness knowledge for solving personal and societal problems (AAAS, 1993; Canton, Brewer, & Brown, 2000; Singh, Granville, & Dika, 2002). Educational research consistently supports the value of scientific inquiry as a motivational tool (Canton, Brewer, & Brown, 2000; Coleman, 2001). Another motivational approach in teaching science is the integration of science concepts with relevant applications in society, including technology (AAAS, 1993; Bennet, Lubben, & Hograth, 2007; Nieswandt &Shanahan, 2008). In addition, incorporation of real world issues in the 21st century also increases students' motivation (Glynn, Taasoobshirazi, & Brickman, 2007).

Relevancy of Learning

According to Pickens & Eick (2009), too many students enter the science classroom with preconceived ideas that the subject is boring and irrelevant to their world. Although there are a multitude of connections to be made among science, technology, and life outside the classroom, student disinterest continues to plague educators (Pickens & Eick, 2009). Making science relevant to students' personal lives makes science worth studying for reluctant learners and those students who are not interested in science

(Daniels & Arapoststhis, 2005; Sagor, 2002; Strong, Silver, & Robinson, 1995). Research has shown that even reluctant learners become engaged in activities if they see a value in the lesson for their present lives (Bennet, Lubben, & Hograth, 2007; Daniels & Arapoststhis, 2005; Nieswandt & Shanahan, 2008; Smith & Wilhelm, 2002; Theobald, 2006). When educators indicate how science is relevant to students' daily lives, students become more motivated to learn science.

Constructivism

Learning theories can be classified as objectivist or constructivist. According to Bas (2012), the traditional learning theories can be called objectivist, an approach stating that knowledge depends on an objective reality and is an absolute entity. Unlike the objectivist approach, the constructivist approach emphasizes that learning is the learner's construction of his/her own knowledge in his/her mind Arisoy, 2007). Constructivism, one of the most popular learning theories, tries to explain the nature of learning (Brooks & Brooks, 1999). The way in which people try to make sense of situations or, in other words, how people create meaning, is the main concern of the constructivist learning theory (Loyens & Gijbels, 2008).

Constructivism has served as the underpinning theory for many of the current reform efforts in science education and has been one of the most influential themes in science teaching and learning since the 1980's (Fensham, 1992; Chang et al., 2010). Current US science education reform documents and standards recommend teaching practice based on constructivism (NRC, 1996; Rutherford & Ahlgren, 1990); however, constructivism is not a new concept. It is a common belief that the concept of constructivism was derived from Piaget's (1955) reference to constructivist, as well as

Bruner’s (1966) description of discovery learning and from Vygtosky’s (1978) views on sociocultural learning.

Constructivist learning is a philosophical view which is interested in arriving at knowledge rather than as another independent learning approach (Savery & Duffy, 1996). Constructivism, as an epistemological philosophical view of knowledge acquisition, emphasizes knowledge construction rather than knowledge transmission (Fosnot, 1996). According to constructivism, knowledge construction is based upon learners’ previous knowledge experiences (Bas, 2012). Therefore, new knowledge is integrated with the previous intellectual constructs (Schunk, 2008). The way in which people try to make sense of situations or how people create meaning is the main concern of the constructivist learning theory (Wilson, 1996).

The general sense of constructivism is that it is a theory of learning or meaning making in which individuals create their own new understandings based on their prior knowledge (Richardson, 2003). According to Woolfolk (2001), constructivism is a mode of instruction that emphasizes the active role of the learner in building understanding and making sense of information. Constructivism is a view of learning that sees learners as active participants who construct their own understandings of the world around them and, using past experiences and knowledge, learners make sense of the new information they are receiving (Brown & Adams, 2001, p. 7). Thus, constructivism can be explained as a view of learning that considers the learner as a responsible active agent in his/her knowledge acquisition process (Abbott & Ryan, 1999).

During a review of the educational literature, Matthews (2000) identified eighteen different forms of constructivism in terms of methodological, radical, didactic, and dialectical considerations, yet many theorists and scholars place all forms of constructivism in three radically distinct categories: (1) sociological, (2) psychological, and (3) radical constructivism. According to Windschitl (2002), the literature relevant to educators can sensibly be categorized in terms of cognitive originating in the work of Piaget and social or cultural emphases originating in the work of Lev Vygotsky.

Psychological constructivism is a system of explanations of how learners, as individuals, adapt and refine knowledge (Piaget, 1971). In this view, learners actively restructure knowledge in highly individual ways, basing fluid intellectual configurations on existing knowledge, formal instructional experiences, and a host of other influences that mediate understanding (Windschitl, 2002). Psychological constructivism posits that meaningful learning is rooted in and indexed by personal experience (Brown, Collins, & Duguid, 1989) and that learners maintain ideas (e.g., the workings of the human body, how governments operate, and the meaning of fractions) that seem intuitively reasonable to them (Windschitl, 2002). According to Windschitl (2002), the teacher’s task is to help students move from their inaccurate ideas toward conceptions more in consonance with what has been validated by disciplinary communities.

Unlike psychological constructivism, social constructivism views knowledge as primarily a cultural product (Vygotsky, 1978). From the social constructivist perspective, knowledge is shaped by micro- and macro-cultural influences and evolves through increasing participation within different communities of practice (Cole, 1990; Scribner, 1985). While cognitive constructivism focused on the internal structure of concepts, social constructivism focused on the context of their acquisition (Panofsky, John- Steiner, & Blackwell, 1990). Vygotsky emphasized meaningful, “whole” activities (e.g., conducting scientific inquiries, solving authentic mathematical problems, and creating and interpreting literary texts), as opposed to decontextualized skill-building as the fundamental units of instruction in educational settings; he viewed thinking as a characteristic not only of the child but of the “child-in-social-activities” (Moll, 1990, p. 12).

Ernst von Glasersfeld, who coined the term radical constructivism, defined it as an epistemic theory based on two fundamental propositions. The propositions may be summarized as follows (Glasersfeld, 1995a): radical constructivism one, knowledge is not passively received, but is actively constructed by the cognizing subject; radical constructivism two, the function of cognition is adaptive, and serves the subject’s organization of her own experiential world, not the discovery of an objectively given reality. Radical constructivism assumes that external reality cannot be known and that the knowing subject constructs all knowledge ranging from everyday observations to scientific knowledge; knowing, thus, inevitably reflects the perspective of the observer (Molebash, 2002; Terhart, 2003). According to radical constructivists, it is impossible to judge knowledge as an ontological or metaphysical reality (Terhart, 2003).

Constructivist theory has prompted educators to build constructivist pedagogy (Yilmaz, 2008). Richardson (2003) called constructivist pedagogy "the creation of classroom environments, activities, and methods that are grounded in a constructivist theory of learning, with goals that focus on individual students developing deep understandings in the subject matter of interest and habits of mind that aid in future learning." Fosnot (1996) offered this explanation of constructivist learning: a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insights, constructing new representations and models of reality as human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate.

Richardson (2003) identified three principles as the premises of the constructivist pedagogy: that the teacher first recognize and respect students' backgrounds, beliefs, assumptions, and prior knowledge; provide abundant opportunities for group dialogue aimed at fostering shared understanding of the topic under study; establish a learning environment that encourages students to examine, change, and even challenge their existing beliefs and understandings through meaningful, stimulating, interesting, and relevant instructional tasks; help students develop meta-awareness of their own understandings and learning processes; and introduce the formal domain of knowledge or subject matter into the conversation through a sort of loosely structured instruction and the use of technological tools such as Websites.

Constructivist Learning Environment

The classroom environment is particularly influential in terms of student academic outcomes (Martin & Dowson 2009) and has been defined as the ‘‘general class atmosphere including attitudes towards learning, norms of social interactions, acceptance of ideas and mistakes, and learning structures set by the teacher’’ (Urdan & Schoenfelder, 2006, p. 340). According to Fraser (1998), a learning environment encompasses “social, physical, psychological, and pedagogical contexts wherein learning occurs and which affects student achievement and attitudes” (p. 3). The modern science classroom learning environment is generally characterized as constructivist, adopting student-centered constructive pedagogy where students are encouraged to actively engage in the learning processes (Chang, Hsiao, & Chang, 2011). The teacher's role in a constructivist classroom changes from bestowing information to orchestrating discussion and mediating activities through which students gain an understanding of concepts through action (Beamer, Sickle, Harrison, & Temple, 2008) and students are viewed as collaborators who work together in the learning process (Beamer et al., 2008).

Science educators have been concerned with teaching strategies based on the notions of constructivism in an attempt to enhance students' conceptual understanding in science subjects (Lee & Fraser, 2000). Research on constructivist student-centered approaches is increasingly recognized as having positive impact on cognitive learning and affective development (Chang & Barufaldi, 1999; Esiobu & Soyibo, 1995; Baird & Northfield, 1992; Mulopo & Fowler, 1987). According to researchers, there are certain pedagogical strategies teachers can employ when looking to provide an environment conducive to constructivist learning in which students can succeed (Naylor & Keogh, 1999; Taylor et al., 1994b, 1995). Some of these ways to be a 'constructivist teacher' include providing an environment where the individual constructs knowledge; allowing learners the opportunity to conceive a personal understanding of content through exposure ; and promoting, modelling and engaging students in constructivist learning experiences (Cannon, 1995).

Taylor et al. (1995) identified five components of a critically constructivist learning environment as follows: Personal Relevance is the extent to which subject matter (mathematics or science) is connected to students' outside-of-school experiences. Student Negotiation is the degree to which opportunities exist for students to explain and justify their ideas, to listen and reflect on other students' ideas, and to reflect self-critically on the viability of their own ideas; Shared Control is the extent to which students control, along with the teacher, the learning environment, their own learning goals, design and the management of learning activities, and development and use of assessment criteria. Critical Voice is the extent to which a social climate has been established so that students can question the teacher's pedagogical plans and methods, and express concerns about impediments to their learning. Uncertainty is the amount of opportunities that are provided for students to experience subject knowledge as arising from theory-dependent inquiry, involving human experience and values, evolving and non-foundational, and culturally and socially determined.

Taylor and Fraser's (1991) Constructivist Learning Environment Survey (CLES) allowed researchers and teacher-researchers to monitor the development of constructivist approaches to teaching school science and mathematics. Taylor et al.'s (1995) framework for constructivist learning environments has been utilized by a number of educational researchers both nationally and internationally to investigate a wide range of concerns and parameters within mathematics, science, and technology classrooms (Aldridge et al., 2000, 2004; Nix et al., 2005). The CLES is based on a learning theory of constructivism that underpins recent research in science and mathematics education concerned with developing approaches that facilitate students' conceptual development.

Students are at a good vantage point to make judgments about classrooms because they have encountered many different learning environments and have enough time in class to form accurate impressions (Fraser, 1998, p. 8). Use of student perceptions in the classroom environment as predictor variables has established consistent relationships between the nature of the classroom environment and student cognitive and effective outcomes (McRobbie & Fraser, 1993; Walberg, 1969). Moreover, research involving a person-environment fit perspective has shown that students achieve better where there is more congruence between the actual classroom environment and that preferred by students (Fraser & Fisher, 1983).

Research comparing teacher and student perceptions of the same classroom has generally demonstrated that teachers' perceptions are more positive than those of the students (Dorman, 2008; Fraser, 1982; Raviv, Raviv, & Reisel, 1990; Sinclair & Fraser, 2002). According to Spearman and Watt (2013), research has acknowledged the discrepancy between the "actuality" of classrooms and students' own perceptions of those classrooms that inform their experiences. Additionally, there is large variability in students' perceptions of classroom environment (Wolters, 2004) in that students in the same class do not necessarily perceive the classroom in the same way. As a result of the discrepancy between teacher and student perceptions of the classroom environment, Goodnow (1988) and Wentzel (2002) stressed the importance of focusing on student perceptions of the teacher and the classroom environment because it is students' own perceptions that construct their reality.

Although constructivist teaching strategies have gained increasing recognition and are recommended by educators and researchers in the secondary science education (Chang, 2005), the debate between teacher-centered and student centered methods is ongoing (Chall, 2000; Chang, 2003). There is a disregard for a constructivist approach among some teachers, especially veterans, who believe that the approach creates a chaotic and disruptive classroom environment (Richardson, 2003). Many principals do not want to take the time or resources to reform programs to include constructivism (Beamer, Van Sickle, Harrison, &Temple, 2008). According to Dempsey (2002), some teachers argue that few professional development programs are given about constructivist teaching practices.

Inquiry

Inquiry learning is compatible with the constructivist approach, which emphasizes the idea that knowledge is not transmitted directly from the teacher to the student but is actively developed by the student (Zion & Mendelovici, 2012). According to the National Research Council (2000), when science education is considered within a constructivist framework, the focus of science instruction shifts ‘‘to involve students in doing rather than being told or only reading about science’’ (pp. 16–17). Since the release of the National Science Education Standards (NRC, 1996), the idea of inquiry-based science has served as the foundation for science education reform (Forbes & Biggers, 2014). Reform documents in science education advocate for teachers incorporating inquiry-based instruction into their teaching practice and teaching about the nature of inquiry and nature of science (AAAS, 1989, 1993; NRC, 1996, 2000). Furthermore, inquiry is one principal strategy for engaging students in doing science that is highlighted in the national standards documents and by leading science teaching organizations (AAAS, 1989, 1993; NRC, 1996; National Science Teachers Association [NSTA], 2007).

Even a cursory review of the literature tells us that the best way for students to learn science concepts effectively, think scientifically, and understand the nature of science is to learn through inquiry (Nadelson, 2009; Marshall, Horton, & White, 2009).

Inquiry-based instruction is an important science teaching strategy that involves supporting students in investigating questions and using data as evidence to answer these questions (e.g., Crawford, 2000). Teaching through inquiry is thought to promote scientific literacy (Hodson, 1992) and has the potential to improve both student understanding of science and engagement in science (AAAS, 1989, 1993; NRC, 1996). The NRC (2000) states: "A classroom in which students use scientific inquiry to learn is one that resembles those that research has found the most effective for learning for understanding" (p. 124). When engaging in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations, and communicate their ideas,'' and throughout the process ‘‘they identify their assumptions, use critical and logical thinking, and consider alternative explanations'' (National Research Council, 1996, p. 2). According to the National Science Education Standards (NSES), “scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work” (p.23).

The National Research Council defined inquiry as a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results (NRC, 1996,). Additionally, the NRC defined two types of inquiry; the first describes teaching and the second describes doing science in further detail. Scientific inquiry refers to the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Inquiry also refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world.

Inquiry may be referred to as a technique that encourages students to discover or construct information by themselves instead of having teachers directly reveal the information (Uno, 1999). Inquiry learning challenges students to collaborate with peers, construct knowledge by connecting new and old ideas, relate new science content to their lives in and outside of school, and self-regulate across the weeks that an inquiry project might unfold (Blumenfield et al., 1991; Krajcik et al., 1998). Although inquiry may not be the only way to teach science, many science educators believe that it may be the best strategy for students to learn science (Audet & Jordan, 2005).

A recent synthesis of the literature by Minner et al. (2010) indicated a clear positive trend between inquiry-based instruction and conceptual understanding for students. Results of the inquiry-oriented curriculum programs conducted by Shymansky, Kyle, and Alport (1983) found substantial effect sizes in favor of the inquiry-oriented materials on various qualitative measures, including cognitive achievement, process skills and attitudes to science. Reports reveal that the use of inquiry-based teaching can enhance student comprehension of science concepts (Tobin, McRobbie, & Anderson, 1997; Driver, Asoko, Leach, Mortimer, & Scott, 1994; Trowbridge & Bybee, 1990). Research by Cuevas, Lee, Hart, and Deaktor (2005) indicated that inquiry instruction can yield greater increases in achievement for low-achieving, low-SES at-risk students in particular.

According to the National Research Council (2000), the five essential features of classroom inquiry are: learners engaging in scientifically oriented questions; learners giving priority to evidence; learners formulating explanations from evidence to address scientifically oriented questions; learners evaluating their explanations in light of alternative explanations, particularly those reflecting scientific understanding; and learners communicating and justifying their proposed explanations.

Inquiry-based teaching/learning varies in the amount of autonomy given to students and encompasses a broad spectrum of approaches, ranging from teacher-directed structured and guided inquiry to student directed open inquiry (NRC, 2000). Martin-Hansen (2002) mentioned four types of inquiry—open or full inquiry, guided inquiry, coupled inquiry, and structured inquiry—in order to develop an understanding of the different aspects of inquiry among teachers.

During structured inquiry, students investigate a teacher-presented question through a prescribed procedure and receive explicit step-by-step instructions at each stage, leading to a predetermined outcome, similar to following a recipe (Zion & Mendelovici, 2012). During structured inquiry students are involved through hands-on investigations in the process of science and develop basic inquiry skills, such as making observations, raising hypotheses, collecting and organizing data, drawing conclusions, making inferences, and finding solutions. However, students do not attain the ability to think autonomously because in structured inquiry, questions, processes, and results are known in advance (Zion & Mendelovici, 2012).

During guided inquiry, students investigate questions and procedures that teachers present to them, but the students themselves, working collaboratively, decide the processes to be followed and the solutions to be targeted (Zion & Mendelovici, 2012). Results of guided inquiry investigations are not foreknown to the teachers and students.

Since the teacher provides students with inquiry questions and procedures, the level of uncertainty during the inquiry process is decreased. According to Zion & Mendelovici (2012), the students who ultimately lead the inquiry process are involved in decision making from the data collection stage and may come up with unexpected yet well-conceived conclusions.

In coupled inquiry the teacher combines a guided-inquiry investigation with an open-inquiry investigation (Dunkhase, 2000). During the guided inquiry, the teacher chooses the first question to investigate, specifically targeting a particular standard or benchmark (Martin, 2001). Once students have completed the guided inquiry, they participate in an open inquiry investigation. Teachers utilizing guided inquiry followed by open inquiry results in student-generated questions that closely relate to the standard or benchmark from the first investigation. Specific concepts can be explored in a more didactic fashion allowing students to connect their concrete experiences to abstract concepts, similar to a learning-cycle approach. The coupled-inquiry cycle is as follows: 1) an invitation to inquiry, 2) teacher-initiated "guided inquiry," 3) student-initiated "open inquiry," 4) inquiry resolution, and 5) assessment. This coupled inquiry cycle can then lead back to more student-initiated open inquiry (Dunkhase, 2000; Martin, 2001).

According to Zion & Mendelovici (2012), during open inquiry, the most complex level of inquiry-based learning, teachers outline the knowledge framework in which the inquiry will be conducted but permits the students to select a wide variety of inquiry questions and approaches (student-designed or selected). Consequently, students are engaged in continuous decision-making throughout each stage of the open inquiry process, starting from the stage of identifying the interesting phenomenon to be investigated. Open inquiry emulates the type of research and experimental work that is performed by scientists, and demands high-order thinking capabilities (i.e., questioning, designing an experiment, critical and logical thinking, and reflection). Students who participated in open inquiry demonstrated ownership and responsibility for determining the purpose of the investigation and the question to be investigated as a scientist would (Reid &Yang, 2002).

The role of a teacher in an inquiry based classroom is different from the role of a teacher in a traditional classroom. Instead of simply explaining, demonstrating, and correcting, the teacher must place more emphasis on guiding the student's active learning process (Luft, 2001; Rossman, 1993). Particularly, in the guided and open types of inquiry, the teacher must guide, focus, challenge, and encourage student learning (AAAS, 1993; NRC, 2000; 2012). Descriptors of roles for teachers using constructivist and inquiry-oriented approaches to teach science include "teacher as facilitator," and "teacher as guide" (Crawford, 2000, 2007; NRC, 2012). Crawford (2000) described the role of a teacher in an inquiry based classroom in further detail, and claimed that the teacher must assume a myriad of roles. Such roles require a high level of expertise: the role of motivator, diagnostician, guide, innovator, experimenter, researcher, modeler, mentor, and collaborator.

Unfortunately, many teachers have limited experience with scientific inquiry and hold naive conceptions of the process by which scientific knowledge is generated (Anderson, 2007). Lack of knowledge and experience with inquiry is thought to act as a barrier for teaching science in this way (Blanchard, Sutherland, & Granger, 2009). This lack of knowledge and experience likely puts serious limitations on teachers' ability to plan and implement lessons that will help their students develop an image of science that goes beyond the familiar body of knowledge (Capps & Crawford, 2012).

Even though standards documents advocate inquiry as an instructional strategy, currently open inquiry is seen as problematic by many science teachers and has not been widely accepted or enacted (Campbell & Bohn, 2008; O'Sullivan & Weiss, 1999; Settlage, 2007; Windschitl, 2003). Three reasons inquiry poses problems are: teachers inability or discomfort directing or controlling student inquiry; a perception that open inquiry is too time intensive; and lack of evidence for improved student outcomes (Settlage, 2007). Settlage (2007) stated that holding open inquiry as the purest form of classroom inquiry and suggesting it is an ideal for which science teachers should strive is a myth. It is impractical to expect teachers to implement open inquiry with any regularity, and there is negligible evidence supporting a continued allegiance to a faith in open inquiry. Documented problems identified by teachers when seeking to employ inquiry as an instructional strategy include: lack of clarity with respect to what constitutes inquiry (Bybee et al., 2008); lack of examples of how inquiry is facilitated as an instructional strategy in real classrooms (Settlage, 2007); and the lack of the explicit association of inquiry with science content (Windschitl et al., 2008).

Dominant perspectives in the field of science investigation are shifting away from the five essential features of inquiry and towards an emphasis on scientific practices (argumentation, modeling, etc.—see NRC, 2007). Consequently, current science education reform discourse has begun to emphasize scientific practices as the sense-making activities in which scientists engage as part of a broader participation in scientific inquiry (Forbes & Biggers, 2014). Recent work in the learning sciences and social studies of science has helped illuminate the varied kinds of practices in which scientists actually engage. The practices include argumentation (e.g., Berland & Reiser, 2009; Cavagnetto et al., 2010; Osborne, Erduran, & Simon, 2004), in which scientists justify and negotiate their evidence, explanations, and reasoning, and scientific modeling (e.g., Schwarz et al., 2009; Stewart, Cartier, & Passmore, 2005; Windschitl, Thompson, & Braaten, 2008), in which they use models to represent and serve as reasoning aids about complex natural systems. According to the National Research Council (2007 & 2012), science learning environments should be designed to similarly engage students in these and other scientific practices as part of their broader participation in science as inquiry.

Ethic of Caring

Educators such as Noddings (1984, 1992) and Gilligan (1988) suggest that caring is a vital part of education. Most often teachers work to develop caring relationships in their practice because they know a student is less likely to commit to the instructional program if the student does not believe the teacher is personally interested and emotionally invested in the success of that student (Collier, 2005). Literature that discusses teacher care affirms that students experience positive school outcomes, such as improved attendance, attitude, self-esteem, effort and identification with school, if they believe their teachers care for them and their wellbeing (Steele, 1992; Noblit, Rodgers, & McCadden, 1995; Noddings, 1995).

Students Who Dropout

Despite a steady improvement in overall graduation rates since the 1960s, many students in the United States continue to leave school without a diploma (Balfanz, Bridgeland, Moore, & Fox, 2010). Currently in the United States, graduation rates are estimated to average between 70% and 80% nationally (Balfanz, Bridgeland, Moore, & Hornig Fox, 2010; Cataldi, Laird, & KewalRamani, 2009; Kaufman, 2004). However, for some schools, specifically schools in urban and poor contexts, graduation rates have been shown to be as low as 50% or less (Balfanz, et al., 2010; Balfanz & Legters, 2006; Swanson, 2004). According to some estimates, more than one million students dropout each year, with members of minority groups facing the highest likelihood of dropping out (Crowder & South, 2003; Figueira-McDonough, 2010; Vartanian & Gleason, 1999; Wodtke, Harding, & Elwert, 2011). Most reports on the dropout crisis point to the severity of the problem among black, Hispanic, and other minority youth, especially among boys (Orfield, 2004). Half of all black students in the country do not graduate from high school and for boys the graduation rate is an astonishing 43 percent (Aron, 2006). Rates among Hispanics and American Indians are also low at 48 and 47 percent, respectively (Aron, 2006). According to Balfanz et al. (2004), a recent study found that a high school that serves a majority of minority students is five times more likely than a high school that serves a majority of white students to promote half or fewer of its freshmen students to senior status on time. Eighty percent of the nation’s high schools producing the highest numbers of dropouts are in just 15 states (Arizona, California, Georgia, Florida, Illinois, Louisiana, Michigan, Mississippi, New Mexico, New York, North Carolina, Ohio, Pennsylvania, South Carolina, and Texas) and five southern states lead the country in number and level of concentration of high schools with weak promoting power (Georgia, South Carolina, North Carolina, Florida, and Texas (Aron, 2006).

Students who graduate from high school benefit themselves and society. However, students who drop out of school present several consequences for society. High school graduates live longer (Muennig, 2005), are less likely to become teen parents (Haveman et al., 2001), and are more likely to raise healthier, better-educated children. Children whose parents graduate from high school are themselves far more likely to graduate from high school than are children of parents without a high school degree (Wolfe & Haveman, 2002). High school graduates are less likely to commit crimes (Raphael, 2004), rely on government health care (Muennig, 2005), or use other public services such as food stamps or housing assistance (Garfinkel et al., 2005). Additionally, high school graduates are more likely to engage in civic activity, including voting and volunteering in their communities (Junn, 2005). According to the U.S. Bureau of the Census (2006), the average annual income for a high school dropout in 2005 was $17,299, compared to $26,933 for a high school graduate, a difference of $9,634. Cecilia Rouse (2005), found that each dropout, over his or her lifetime, costs the nation approximately $260,000. Collectively, dropouts cost the nation about $77 billion dollars annually:$3 billion in crime prevention, $3 billion in welfare and unemployment, and $71 billion in lost tax revenue (Wehlage & Rutter, 1986).

At-risk Students

Researchers have been documenting and analyzing for numerous years the ways in which different “at-risk” populations of students continually fall through the cracks of the traditional American system of schooling (Ogbu, 1978; Oakes, Gamoran, & Page, 1992; Stricklank & Ascher, 1992). Students at-risk are individuals who for a variety of reasons have a high frequency of dropping out of school prior to obtaining a high school diploma. At- risk students more often come from low-income families, are members of ethnic minorities, and receive less educational support at home (Eckstrom et. al., 1986). At-risk students have high truancy rates which prevents them from earning the necessary credits toward graduation. Additionally, students at-risk are difficult to engage academically (Tobias, 1992), have behavioral problems in school (Jimerson, Egeland, Sroufe, & Carlson, 2000), have been retained a grade (Jimerson, Anderson, & Whipple, 2002), and work during normal school hours (Karpinski, Neubert, & Graham, 1992). Due to the dropout crisis in America, alternative education programs were created to prevent at-risk students from leaving school prior to earning a high school diploma.

Alternative Education

In an effort to educate children whose needs are not met by traditional schools and present increased risks for dropping out of school, alternative schools are mandated by all states. Emerging in the United States in the 1960s, alternative education programs (AEPs) initially grew out of a desire to meet the needs of poor and minority students underserved in traditional public school systems and to create innovative programming for suburban students (Meyers, 2001; Raywid, 1999). The term alternative education encompasses all types of educational settings that lie outside the traditional K-12 school system (including home schooling, GED preparation programs, special programs for gifted children, and charter schools), although the term is often used to describe programs serving at-risk students who no longer attend traditional schools for various reasons.

Although currently there are a number of different types of AEPs in existence throughout the United States, many of these programs have become a viable means of providing for the education and socialization of youth who have debilitating characteristics, are impoverished, and/or are otherwise at-risk of manifesting social, emotional, and/or behavioral problems in school (Franklin et al., 1990; Grunbaum et al., 2000; Guerin & Denti, 1999; Lange & Sletten, 2002; Powell, 2003; Tobin & Sprague, 2000; Zweig, 2003). Typically, high-risk youth who attend these types of programs have been exposed to negative social and environmental risk factors throughout their lives stemming from problems associated with poverty, family adversity, inadequate parental monitoring, and/or physical and emotional trauma (Guerin & Denti, 1999; Mclntyre, 1993; Waldie & Spreen, 1993). As a result of such negative life experiences, many of these youth display academic and behavioral difficulties that ultimately lead to their expulsion from traditional schools and eventual transfer to alternative education programs within the school system (Carpenter-Aeby & Kurtz, 2000; Guerin & Denti, 1999). When these behavioral patterns persist in spite of remedial intervention ordinarily available in general school settings, many of these youth experience such negative consequences as school dropout, delinquency, drug use and trafficking, and/or other serious life-long problem behaviors (Aron, 2006; Grunbaumal, 2000; Tobin & Sprague, 2000; Zweig, 2003). Alternative education programs are designed to provide such youth a second opportunity to succeed within the established public education environment (Carpenter-Aeby & Kurtz, 2000; Reilly & Reilly, 1983).

Common characteristics of alternative schools identified in a review of the literature by Lange & Sletten (2002) included small size, one-on-one interaction between teachers and students, a supportive environment, student-centered curriculum, flexibility in structure, and opportunities for students to engage in decision-making. Individualized instruction is provided which meets students' unique academic and social-emotional needs (Franklin, 1992; Lange & Sletten, 2002) and alternative education programs provide supportive environments that strengthen relationships among peers and between teachers and students (Franklin, 1992; Lange & Sletten, 2002).

Highly effective alternative education programs are generally known for their adherence to youth development principles (Smith & Thomas, 2001; NGA Center for Best Practices, 2001) such as: (1) physical and psychological safety (e.g., safe facilities, safe ways to handle conflicts between youth); (2) appropriate structure (i.e., limit setting, clear rules, predictable structure to how program functions); (3) supportive relationships (i.e., warmth, closeness with adults and peers); (4) opportunities to belong (i.e., meaningful inclusion); (5) positive social norms (i.e., expectations of behaviors); (6) support for efficacy and mattering (e.g., empowering youth, challenging environment, chances for leadership); (7) opportunities for skill building (e.g., learning about social, communication skills, as well as media literacy, good habits of the mind); and (8) integration of family, school, and especially community efforts (National Research Council and Institute of Medicine, 2001). According to Guerin and Denti (1999), successful alternative education programs have certain qualities including: curricula that is responsive to the needs of the students; assessment; teaching of social skills, social responsibility, and restorative justice; focus on core academic subjects; and a presence of supplementary subjects (e.g., career awareness).

California’s Alternative Education Programs

Since 1965, California’s state law has mandated that all school districts enrolling over 100 12th grade students provide a continuing education program that provides an alternative route for students to earn a high school diploma for individuals vulnerable to academic or behavioral failure (Velasco, 2008). California's Alternative Education Options, programs which annually enroll between more than 320,000 of the state's high school students, include a range of services: district-run continuation schools; independent study programs and community day schools; and county-operated community schools and community day schools (McLaughlin, Atukpawu, & Williamson, 2008). There are approximately 850 alternative high schools in California, excluding charter schools. Of these schools, about 500 are continuation high schools (designed for over-age/under-credited students in grades 10-12); 294 are district or county-administered community day schools (designed for students who have been expelled from traditional schools for disciplinary reasons or who are on probation and referred from the juvenile justice system); and another 56 are community schools operated by county education offices that may, like continuation high schools, offer independent study as an educational option (Warren, 2006).

California's Continuation High Schools

In California, continuation high schools were originally conceptualized to allow working youth to receive an education while tending to occupational responsibilities outside of school. Continuation education takes several forms: as "part-time" continuation classes offered in a traditional high school; as a "school-within-a-school" model where a separate continuation program exists adjacent to a traditional high school; or as an independent continuation high school with its own campus (McLaughlin, Atukpawu, & Williamson, 2008). In compliance with state law, these schools are generally operated by districts and provide high school students (ages 16 and older) with personalized attention in a small classroom setting. Of all alternative education programs, continuation schools tend to have the highest rate of enrollment and serve students longer than the other alternative education programs (McLaughlin, Atukpawu, & Williamson, 2008). Most continuation schools have a population of less than 200 students and a student-teacher ratio of 17.4 to 1.

Characteristics of Students Who Attend California's Continuation High Schools

The single common denominator is that most continuation students have reached age 16 lacking sufficient academic credits to remain on track to graduate with their age cohort, but the data also reveal them to be a highly vulnerable population characterized by multiple risk behaviors and other nonacademic learning barriers (WestEd, 2008). The parents of students attending alternative education schools have lower educational levels than parents of students in comprehensive schools. African-American and Latino students are more likely to attend alternative education schools while Asian students are less likely to be part of the system (McLaughlin, Atukpawu, & Williamson, 2008). Approximately 71% of students in the alternative education system are minority youth, and English learners are also over-represented in continuation high schools (WestEd, 2008). Research also indicates that there is a higher percentage of youth needing special education services in the alternative education system (Dixon, 2006).

Compared to students attending comprehensive schools, continuation students are more likely to transfer from school to school as a result of family moves and changes in students' foster home placements. Almost half (47 percent) of continuation students reported being enrolled in any one continuation school for fewer than 90 days, giving these schools very little time to help them (WestEd, 2008). Continuation students surveyed using the California Healthy Kids Survey (CHKS) were three times more likely than their comprehensive (traditional) high school counterparts to be in foster care or living with a relative other than a parent. Reportedly, many youth are also single teen parents who lack adequate resources and support necessary to care for themselves along with their child (Aron & Zweig, 2003). Parental mental health issues also play a role in shaping the behavior of these youth who are often diagnosed with attention deficit hyperactivity disorder (ADHD), depression, or bipolar disorder (McLaughlin, Atukpawu, & Williamson, 2008).

Rates of regular and heavy alcohol and drug use (including use at school) are at least two times higher among continuation students than 11th-grade students in comprehensive schools with methamphetamine use and daily marijuana use about five times higher among continuation students (WestEd, 2008). Approximately one-fifth of continuation students reported being drunk or high at school on seven or more occasions on the CHKS. Continuation students are about three times more likely than 11th graders statewide to have been in four or more physical fights at school in the past 12 months, as well as to have carried a gun to school (13 percent for both versus 3-4 percent for 11th graders in comprehensive schools) according to the CHKS (WestEd, 2008). According to the CHKS, 14 percent of continuation students have gang affiliations which are twice the percentage of students surveyed statewide. Additionally, nine percent of continuation students report being threatened or injured with a weapon more than once, over double the rate of 11th graders statewide (4 percent).

Summary of the Literature Review

Although alternative education programs continue to grow in scope and size throughout the United States, with approximately 20,000 such programs currently in existence (Barr & Parrett, 2001), limited empirical research is available regarding the feasibility of these programs or the types of students who attend them (Aron, 2006; Barr & Parrett, 2001; Foley & Pang, 2006; Hosley, 2003; Powell, 2003; Zweig, 2003). The unique characteristics of alternative programs and the diverse populations they serve have made rigorous evaluation very difficult (Tobin & Sprague, 2000). Consequently, few studies regarding the effectiveness of AEPs have been conducted. The results of those that have been conducted need to be replicated in new settings (Cox, 1999; Cox, Davidson, & Bynum, 1995; Duke & Griesdom, 1999; Kochhar, 1998). What evidence is available, however, indicates that well-designed alternative education programs can benefit students at risk for failure in traditional programs (Guerin & Denti, 1999; Nichols & Utesch, 1998; Raywid, 1990, 1998).

A vast amount of research exists which characterizes students considered at-risk for dropping out of high school. Current research explains how an individual's self-efficacy affects their motivation and how an individual's self-esteem affects positive attitudes toward school and learning. Current research in science teaching espouses the need for teachers to incorporate constructivist teaching approaches including inquiry based instruction to teach all science students. Previous studies have revealed, however, that while relatively negative feelings of students are usually associated with more traditional approaches to science instruction (Lord, 1997; Shepardson & Pizzini, 1993), their perceptions of science classrooms as constructivist are correlated positively to student attitudes (Aldridge et al., 2000; Fisher & Kim, 1999; Hand et al., 1997). However, the review of the literature did not result in research indicating the correlation between teachers' use of instructional methods on the attitudes of at-risk students enrolled in science classes. Of particular interest in the proposed study is the relationship between students' motivation to learn science and the teacher's use of inquiry based activities to teach science.

CHAPTER 3

METHODOLOGY OF AT-RISK SCIENCE STUDENTS ATTENDING ALTERNATIVE EDUCATION PROGRAMS

Participants

Participants in the research study include four alternative education science teachers and their students. Pseudonyms were used to maintain the privacy of the teachers involved in the research study. The pseudonyms are Anthony, Nancy, Lisa, and Robert. Schools in which the teachers are employed are labeled A, B, C, and D, and the names of the school districts are not mentioned, also to protect the privacy of the teachers and their students involved in the research study.

Teacher sample. The four participating biology teachers were from suburban and urban alternative education high schools in Northern California. Their teaching experience ranged from three to 25 years (see Table 3.1 for a summary of the participating teachers), and the teachers' mean teaching experience was 12 years. The sample included two males and two females. Two teachers had master's degrees in education; two teachers had bachelor's degrees in biology, one a bachelor's degree in molecular and environmental biology, and one a bachelor's degree in anthropology. Two teachers held a clear certificate and two teachers held a preliminary certificate

The teachers were recruited through emails sent to alternative education biology teachers in seven school districts in Northern California requesting their participation in a dissertation study. The districts were chosen based on their proximity to the researcher, and four teachers were selected based on their willingness to participate in the study.

Table 3.1

Summary of Participating Alternative Education Science Teachers

Teacher	Years of Teaching Experience	Highest Level of Education Attained	Type of Teaching Certificate	Subjects Taught
Anthony	25	Masters	Clear	Biology and Health
Nancy	14	Masters	Clear	Biology
Lisa	3	Bachelors	Preliminary	Biology and Earth Science
Robert	4	Bachelors	Preliminary	Biology and Conceptual Physics

Student sample. Twenty-nine ninth through twelfth grade biology students from four suburban and urban alternative education high schools in Northern California participated in the study. Student participants were from diverse backgrounds. School A enrolled a total of 202 students and was composed of 51% Hispanic or Latino, 2% American Indian or Alaska Native, 4% Asian, 1% Pacific Islander, 3% Filipino, 28% African American, 5% White, 3% Two or More Races, and 0.5 % Not Reported. Sixty-six percent of the student population was considered socioeconomically disadvantaged. School B enrolled a total of 126 students and was composed of 23% Hispanic or Latino, 2% American Indian or Alaska Native, 3% Asian, 2% Filipino, 6% African American, 63% White, and 2% Two or More Races. Seventeen percent of the student population was considered socioeconomically disadvantaged. School C enrolled a total of 148 students and was composed of 39% Hispanic or Latino, 0.7% Asian, 1% Pacific Islander, 0.7% Filipino, 57% African American, 0.7% White, and 0.7 % Not Reported. Eighty-six percent of the student population was considered socioeconomically disadvantaged. School D enrolled a total of 80 students and was composed of 36% Hispanic or Latino, 3% Asian, 1% Pacific Islander, 1% Filipino, 6% African American, 51% White, and 1% Two or More Races (numbers do not equate 100 percent due to rounding). Twenty-eight percent of the student population was considered socioeconomically disadvantaged.

Procedure

Data collection consisted of teacher interviews, classroom observations, student focus groups, teacher surveys, and student surveys. The initial data collection period occurred between August and December of 2012. The researcher was employed as a full-time science teacher during the data collection period. The data was collected during school hours, making it necessary for the researcher to take time off from work to collect the data.

Initial teacher interviews. Once teachers agreed by email to participate in the research, an initial interview (Appendix J) was scheduled based on the teachers’ and the researcher’s availability. The interviews occurred in the teachers’ classrooms. After the interview, the first classroom observation was scheduled.

The four teachers were interviewed to determine their years of experience, degrees earned, type of teaching certificate held, classes they were assigned to teach, participation in science professional development, interaction with other science teachers, availability of materials, and strategies used to motivate students to learn science. Additionally, the interview was utilized to ascertain the teachers’ degree of inquiry based instruction.

Classroom observations. Each teacher was observed three times using the Electronic Quality of Inquiry Protocol Scale (EQUIIP) designed by Marshall, Horton, Smart, and Llewellyn (2008) to determine their level of inquiry. The EQUIIP is designed to measure the quantity and quality of inquiry instruction in a classroom setting. The form places teachers onto an inquiry continuum by classifying the teachers as pre-inquiry, developing inquiry, proficient inquiry, or exemplary inquiry (see Table 3.2 for an interpretation of the scores). It is organized into seven sections with Section I completed before and during the observation, Sections II and III during the observation, and Sections IV - VII immediately after the observation. The factors covered by the EQUIP are instructional, discourse, assessment, and curriculum.

Table 3.2

Interpretation of Inquiry Score from the Electronic Quality of Inquiry Protocol

Inquiry Score Range	Meaning of Score Range
1	Pre-Inquiry
2	Developing Inquiry
3	Proficient Inquiry
4	Exemplary Inquiry

The researcher observed the lessons between August and December 2012 to gain an idea of each teacher's degree of inquiry based instruction. During the classroom observations, the researcher acted as a non-participant observer, and all observations were audio taped.

Focus groups. A focus group (Appendix L) was conducted of each teacher's students once the classroom observations were completed. The focus group participants included students present in class the day the focus group was scheduled. Students were informed that they were not required to participate in the focus group and, therefore, volunteered to participate. The focus group was conducted in the teacher's classroom, and the teacher was asked to leave the classroom which allowed students to speak freely. The focus group consisted of 18 questions and was designed to last approximately 45 minutes. Students compared and contrasted their science classes at the comprehensive schools they attended previously to the alternative school they were currently attending. They shared their thoughts on the teaching strategies utilized by their current alternative education high school science teacher and how those strategies motivated them to learn science, failed to motivate them to learn science, improved their attitudes toward science, or failed to improve their attitudes toward science.

Teacher surveys. The teacher participants completed Bandura's Instrument Teacher Self-Efficacy Scale (TSES) to determine their degree of self-efficacy and the Science Teaching Efficacy Belief Instrument Form A for in-service teachers (STEBI-A) (Enochs & Riggs, 1990) to measure efficacy of teaching science. Teachers completed the surveys after the student focus groups were conducted. Two of the teachers completed paper surveys during a scheduled meeting between the teacher and the researcher. The other two teachers completed the surveys online via Survey Monkey due to time constraints.

The TSES consists of 30 items with a 9-point Likert Scale anchored at 5 points and has seven scales which are positively worded. The seven subscales include: efficacy to influence decision making, efficacy to influence school resources, instructional self-efficacy, disciplinary self-efficacy, efficacy to enlist parental involvement, efficacy to enlist community involvement, and efficacy to create a positive school climate. The response choices on the TSES are from 5 (*a great deal*) to 1 (*nothing*). The maximum score on the TSES is 150, and the minimum score is 30. Teachers who score 111.5 or above on the TSES possess a high self-efficacy for teaching (Appendix B). According to Lam (2012), the instructional self-efficacy subscale was found to be significantly correlated with all other subscales ($.32 \leq r \leq .60$, Ps < .05).

The STEBI-A (Enochs & Riggs, 1990) consists of 25 questions on a 5-point Likert Scale and are divided into two subscales: personal science teaching efficacy beliefs (PSTE) and science teaching outcome expectancy (STOE). The response choices are from 5 (*strongly agree*) to 1 (*strongly disagree*). Of the 25 questions, 12 questions are negatively scored. The PSTE scale reflects science teachers' confidence in their ability to teach science and includes questions 2, 3, 5, 6, 8, 12, 17, 18, 19, 21, 22, 23, and 24. The STOE scale reflects science teachers' beliefs that student learning can be influenced by effective teaching and includes questions 1, 4, 7, 9, 10, 11, 13, 14, 15, 16, 20, and 25. The maximum score on the STEBI-A is 125 and the minimum score is 25. A score of 92.25 (Appendix C) or above indicates high science teaching efficacy beliefs. After reverse scoring of negatively worded items, high scores on the PSTE subscale indicate greater science teaching self-efficacy beliefs to have positive student outcomes (Abayomi & Oludipe, 2010). Likewise, high scores on the STOE subscale indicate greater outcome expectancy related to the power of teaching to overcome any negative influences that lie outside the classroom (Abayomi & Oludipe, 2010). The coefficient alpha for PSTE scale was 0.92 while the alpha for the STOE scale was 0.77 (Riggs & Enochs, 1990).

Student surveys. Students in the teachers' classrooms completed the Science Motivation Questionnaire (SMQ) created by Glynn & Koballa (2005), the Scientific Attitude Inventory (SAI II) by Moore and Foy (1997), and the Constructivist Learning Environment Survey (CLES). The student surveys were completed after the teacher surveys were collected. The researcher scheduled a date to administer the student surveys, and they were completed during one class period. The classroom observations, student focus groups, and the student surveys were all scheduled during the same class period to ensure that the same students participated in all three forms of data collection.

The purpose of the surveys was to ascertain how motivated the students of each teacher are to learn science, their attitude toward science, and the students' perception of the degree of constructivism practiced in the classroom. Students were informed not to write their names on the surveys to ensure confidentiality. The researcher informed students that there were no right or wrong answers. Students completed the SMQ first and the CLES last.

The SMQ consists of 30 items with a 5-point Likert Scale ranging from 1 (never) to 5 (always). The factors measured by the questionnaire are intrinsic motivation and personal relevance, self-efficacy and assessment anxiety, self-determination, career motivation, and grade motivation. The motivational components and their associated items included intrinsically motivated science learning (items 1, 16, 22, 27, and 30), extrinsically motivated science learning (items 3, 7, 10, 15, and 17), personal relevance of learning science (items 2, 11, 19, 23, and 25), self-determination (responsibility) for learning science (items 5, 8, 9, 20, and 26), self-efficacy (confidence) in learning science (items 12, 21, 24, 28, and 29), and anxiety about science assessment (items 4, 6, 13, 14, and 18). The anxiety about science assessment scale is negatively scored so a higher score on this scale indicates less anxiety. All other scales are positively scored. The maximum total score on the questionnaire is 150 and the minimum is 30 (see Table 3.3 for an interpretation of the SMQ scores). Previous findings by Glynn & Koballa (2006) indicate that the SMQ is reliable in terms of its internal consistency, as measured by coefficient alpha ($\alpha = .93$), and valid in terms of positive correlations with college students' science grades, decision to major in science, interest in science careers, and number of science courses taken.

Table 3.3

Interpretation of Scores from the Science Motivation Questionnaire

SMQ Score Range	Meaning of Score Range
120 - 150	Often to always motivated
90 - 119	Sometimes to often motivated
60 - 89	Rarely to sometimes motivated
30 - 59	Never to rarely motivated

The SAI II, based on a 5-point Likert Scale ranging from agree strongly to disagree strongly, consists of 30 questions with 12 position statements. Six position statements are positive and are labeled 1-A through 6-A. Six position statements are negative and are labeled 1-B through 6-B. The 12 position statements are: 1A The laws and/ or theories of science are approximations of truth and are subject to change; 1B The laws and/ or theories of science represent unchangeable truths discovered through science; 2A Observations of natural phenomena and experimentation are the basis of scientific explanation; 2B The basis of scientific explanation is in authority; 3A To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence; 3B To operate in a scientific manner, one needs to know what others think; 4A Science is an idea-generating activity; 4B Science is technology-developing; 5A Progress in science requires public support in this age of science; 5B Public understanding of science would contribute nothing to the advancement of science or human welfare; 6A Being a scientist or working in a job requiring scientific knowledge and thinking would be very interesting and rewarding life's work; 6B Being a scientist or working in a job requiring scientific knowledge and thinking would be dull and uninteresting. The positive statements comprise questions 1, 2, 3, 5, 6, 8, 9, 12, 13, 14, 18, 20, 23, 26, and 28. The negative statements include questions 4, 7, 10, 11, 15, 16, 17, 19, 21, 22, 24, 25, 27, 29, 30, and are reverse scored. The maximum total score on the questionnaire is 150 and the minimum is 30 (see table 3.4 for an interpretation of the scores). Students who score above 109 (Appendix D) on the SAI II possess a high attitude toward science and students who score less than 109 on the SAI II possess a low attitude toward science. The maximum score on the positive and negative subscales is 75, and the minimum score is 15. Students who score 58 or more on the positive and/or the negative subscale possess a high attitude toward science for the respective subscale (Appendix E). Students who score less than 58 on the positive and/or the negative subscale possess a low attitude toward science for the respective subscale

Table 3.4

Interpretation of Scores from the Scientific Attitude Inventory

SAI-II Score Range Total Scale	SAI-II Score Range Positive/Negative Subscale	Meaning of Score Range
109-150	58-75	High attitude toward science
30-109	57-15	Low attitude toward science

The CLES consists of 34 positively worded questions on a 5-point Likert Scale ranging from 5 (*almost always*) to 1 (*almost never*). Each question consists of two versions: what I think the classroom is like and what I prefer the classroom to be like. The survey has six scales: personal relevance, questions 1-4; science uncertainty, questions 5-8; student negotiation, questions 9-12; investigation, questions13-18; involvement, questions19-26 ; and cooperation, questions 27-34. The personal relevance subscale focuses on the connectedness of school science to students' out-of-school experiences, and with making use of students' everyday experiences as a meaningful context for the development of students' scientific and mathematical knowledge (Taylor, Fraser, & White, 1997). The uncertainty scale was designed to assess the extent to which opportunities are provided for students to experience scientific and mathematical knowledge as arising from human experience and values, as evolving and insecure, and as culturally and socially determined (Taylor, Fraser, & White, 1997?). The student negotiation scale 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, Fraser, & White, 1997).

For each teacher, the researcher compared the teachers' degree of inquiry based instruction from the interview and the classroom observations to the students' responses on their SMQ, SAI II, and CLES surveys. The differences and similarities between the degrees of inquiry based instruction provided insights into the students' attitudes toward science and motivation to learn science.

Second teacher interview. Two years after the initial teacher interviews were conducted, teachers participated in a second telephone interview (Appendix K). Teachers were contacted by email, and the researcher asked them to designate a date and time for the second interview. The purpose of the second interview was to provide teachers an opportunity to elaborate on themes which emerged from analysis of the qualitative data. The interview consisted of seven questions and lasted approximately 15 minutes. Two of the teachers were no longer employed by alternative education schools, and the other two teachers were still employed by the same alternative education schools and taught the same subjects.

Data Analysis

The qualitative data analysis began after the initial qualitative data were conducted and the quantitative data analysis occurred after all of the survey data were collected. After the qualitative data were completely analyzed, supplementary qualitative data, in the form of additional telephone interviews, were collected to clarify themes which emerged from the initial analysis of the data. Analysis of the qualitative and quantitative data from this dissertation allowed me to understand how teachers' use of inquiry based instruction affects students' attitudes toward science and motivation to learn science from the students' perspective.

Qualitative analysis. The qualitative data analysis began with an analysis of the initial teacher interview data followed by an analysis of the student focus group data. A general inductive approach was utilized to analyze the qualitative data. Each teacher's interview was summarized individually. Then the four summaries were analyzed to discover relationships which existed across all four teachers. Next, the summaries were analyzed to discover differences which existed between the four teachers.

The researcher analyzed and summarized each of the student focus group transcripts. The summaries were further analyzed to discover relationships which existed across the four focus group transcripts. The researcher looked closely at themes which emerged from each group relating to teachers' instructional style and the amount of inquiry based activities. The themes were further analyzed to determine themes which occurred across all four groups of students. Next, the researcher analyzed what motivated students to learn in each classroom, while also looking at differences among the four teachers regarding instructional style. Themes which emerged from the qualitative data analysis included limited materials, real world relevancy, and caring teacher-student relationships.

An additional phone interview was conducted with each teacher, and the phone interviews were summarized. The summaries were analyzed to discover themes which were evident in all four cases. Themes which emerged from the phone interview were compared to themes which emerged in the initial teacher interview.

Quantitative analysis. The quantitative data from the teacher and student surveys were analyzed using the Statistical Package for Social Sciences (SPSS) version 22.0 for Windows. Averages, standard deviations, Analysis of Variance (ANOVA) and Repeated Measures Analysis of Variance (ANOVA) were calculated to determine significant trends and patterns in the data. Cut scores of the TSES, STEBI-A, and the SMQ for the 75th percentile were calculated.

Each teachers' EQUIP scores were averaged and the means were calculated to determine the teachers' instructional style out of a total score of four. Results of the students' surveys were compared to the teachers' instructional style to find similarities and differences in the students' perception of the amount of inquiry used in the classroom. Table 3.2 provides an explanation for the range of possible scores on the EQUIP, Table 3.3 provides an explanation for the range of possible scores on the SMQ, and Table 3.4 provides an explanation for the range of possible scores on the SAI-II.

Validity

Validity is generally understood by educational researchers as "the trustworthiness of inferences drawn from data" (Eisenhart & Howe, 1992, p. 644). The depth associated with qualitative research, coupled with researchers' efforts to triangulate (Denzin, 1978) and cross-check (Douglas, 1976) their data, gave this methodology strength in the area of validity. Multiple informants and multiple methods of data gathering or triangulation within a same study are themselves recursive checks against the validity of the researchers' interpretations (Brewer & Hunter, 1989). Creswell and Miller (2000) identified eight verification (a term they prefer to validity) procedures often referred to in the literature and make the point that different procedures may be more appropriate for different traditions within qualitative research. The eight procedures identified by Creswell and Miller are: (a) prolonged engagement and persistent observation, (b) triangulation, (c) peer review or debriefing, (d) negative case analysis, (e) clarifying researcher bias, (f) member checks, (g) thick description, and (h) external audits (see pp. 126-127). Additionally, Creswell (1998) recommends that qualitative researchers engage in at least two of the eight verification procedures in any given study.

The researcher used at least two of the eight verification procedures as recommended by Creswell. The researcher used multiple informants by obtaining data from four alternative education teachers and their students. The researcher used multiple methods of gathering data in the form of teacher interviews, student focus groups, teacher surveys, student surveys and classroom observations. The researcher triangulated the teacher interviews, classroom observations, and student focus group interviews to validate the teachers’ instructional style. Member checking was also utilized by the researcher to establish validity. During the second interview, the researcher shared the interview transcripts, focus group transcripts, and themes which emerged from the qualitative data with each teacher and allowed the teacher to elaborate on the findings. This also allowed the researcher to ensure that the assumptions gained through the dissertation study were valid.   Internal validity was established through triangulation and member checks, and reliability was established through triangulation. The researcher ran Cronbach's alpha on the SAI-II to establish its internal consistency. Cronbch's alpha for the entire scale was .78, the positive scale was .84 and the negative scale was .60.

CHAPTER 4

ALTERNATIVE EDUCATION TEACHER FINDINGS

As described in the methods section, all four teachers were interviewed by the researcher to ascertain preliminary information pertaining to their perceived instructional style regarding inquiry based instruction; three classroom observations were conducted of each teacher by the researcher to further establish their instructional style; and their students participated in a focus group to validate the teachers' instructional style from a students' perspective. The teachers also completed Bandura's Instrument Teacher Self-Efficacy Scale (TSES) to determine their degree of self-efficacy and the Science Teaching Efficacy Belief Instrument (STEBI-A) form A for in-service teachers to measure efficacy of teaching science.

Anthony

Anthony, a white male age 50-59, taught biology and health at an urban alternative education high school in Northern California which employed 16 teachers. He had twenty-five years of teaching experience, a Single Subject Clear California Teaching Certificate in Biological Science, and a Master's Degree in Education. During the past two years, Anthony participated in several types of science professional development which included instruction in content, pedagogy, curriculum, technology integration, improving students' critical thinking or inquiry, and assessment. He rarely participated in discussions with other science teachers about how to teach a particular concept or the preparation of instructional materials. Anthony never visited the classrooms of other teachers to observe their teaching practices nor did teachers visit his classroom to observe him.

School. The school enrolled a total of 202 students ages 16-18 and was composed of 51% Hispanic or Latino, 2% American Indian or Alaska Native, 4% Asian, 1% Pacific Islander, 3% Filipino, 28% African American, 5% White, 3% Two or More Races, and 0.5 % Not Reported. Sixty-six percent of the student population was considered socioeconomically disadvantaged. Of the 202 students enrolled, one was in ninth grade, five were in tenth grade, 162 were in eleventh grade and 162 were in twelfth grade. Students enrolled at the school also had the option to participate in independent study or home study. The school day consisted of five periods 45 minutes in length, a 45 minute advisory period, and a 30 minute lunch. Teachers also had a daily 65 minute preparation period. The school offered all of the major courses to include physical science, Earth science, biology, health, general math, algebra, geometry, California High School Exit Examination (CAHSEE) math, English, CAHSEE English, history, US History, government, economics, computer technology, art, music, physical education, and special education.

Classroom. Anthony taught in a classroom which did not have space for students to conduct laboratory investigations. The class was equipped with 30 desks, all aligned in 6 neat rows, and the classroom did not have a sink or laboratory safety equipment. His teacher's desk was located at the front of the classroom beside the door. There were two white boards, one at the front of the classroom behind the teacher's desk, and the other located on the back wall of the classroom. Seven computers were located on a counter on the right side of the classroom; though they were old, internet access was available. The classroom did not have a Smart Board, but Anthony used a LCD projector which was located on his desk frequently to show videos and images which correlated to the learning. The students used the California edition of the cheetah (on the front) Holt Biology textbook. Anthony only had a class set of textbooks, and the books remained in the classroom.

Observation one. The focus of the lesson during Anthony's first observation was Cnidarians (see table 4.1 for an explanation of the EQUIP scores). The lesson began at 8:30 and ended at 9:15. The class consisted of a total of thirteen students, ten males and three females. Instructions written on the board included A) pages 658 - 661; B) define key terms; C) copy and answer key ideas; and D) answer numbers three and four page 661.

The lesson began with Anthony providing a brief introduction about Cnidarians. Throughout the five minute introduction, several students arrived to class late and once the introduction was given, Anthony took attendance. Anthony then began the class discussion by asking the question, "Has anyone in here other than me ever had jellyfish?" A student responded, "You telling me you eat jellyfish, do they fry it?" Anthony replied "No, they generally sauté it." An announcement was made over the intercom and ten minutes into the class period students began to work independently to complete the book assignment written on the board. Twenty minutes into the class period, a student asked Anthony for assistance with question number five, and he assisted her.

Students were given 15 minutes to complete the book assignment. However, only a few students were able to complete the assignment and submitted it to Anthony during the 15 minute period allotted. After collecting the assignment from students who completed it in 15 minutes, Anthony tried to facilitate a class discussion which lasted 15 minutes, even though several of the students had not completed the book assignment. He turned on the LCD projector and showed the class several pictures of sea anemones. Anthony then showed an image which contained a clownfish and a sea anemone and discussed how animals live together cooperatively. Anthony then showed an image of a man with several scars on his chest due to being stung by a jellyfish. Anthony concluded the lesson by showing an image of a Portuguese man-of-war and discussed how tentacles sting people. While he lectured, the students who completed the assignment sat passively, and those who had not completed the assignment continued working. Anthony remained at his desk the entire class period instead of walking around the classroom to interact with students and monitor their progress.

Table 4.1

EQUIP Scores of Anthony's First Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	1
	Order of Instruction	1
	Teacher Role	1
	Student Role	1
	Knowledge Acquisition	1
Instructional Comprehensive Score		1
	Questioning Level	1
	Complexity of Questions	1

Discourse	Questioning Ecology	2
	Communication Pattern	1
	Classroom Interactions	1
Discourse Comprehensive Score		1
Assessment	Prior Knowledge	1
	Conceptual Development	1
	Student Reflection	1
	Assessment Type	1
	Role of Assessing	1
Assessment Comprehensive Score		1
Curriculum	Content Depth	1
	Learner Centrality	1
	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1
Overall View of the Lesson		1

Observation two. During Anthony's second observation, students studied Animal Behavior, and the class consisted of eleven students, nine males and two females (see table 4.2 for an explanation of the EQUIP scores). Instructions written on the board included A) pages 813 - 819; B) define key terms; and C) copy and answer key ideas.

Attendance was promptly taken at 8:30, and Anthony read the instructions on the board. After the instructions were given, one student commented, "That's a lot of key terms." Anthony did not reply. While seated at his desk, Anthony turned on the LCD projector, showed a video clip from nobelprize.org titled *Pavlov's dog* and discussed the clip with the class for five minutes. After the discussion, students were given fifteen minutes to complete the class work assignment. Twenty minutes into the class period, Anthony wrote the words Pavlov, imprinting, and modern advertising on the board. Anthony proceeded to relate Pavlov and classical conditioning to school bells. He then related classical conditioning to advertising by mentioning how cigarette and alcohol commercials associate sex with the use of their products. As Anthony discussed the topic, most students were still completing the key terms. Anthony continued the lesson by showing a YouTube video of imprinting geese. During the video, several students were still completing the key terms, two students listened to their music, and only two students watched the video. Once the video ended, Anthony discussed innate behavior and nature versus nurture. During the twenty minute discussion, the students sat quietly, but none of them actually participated in the discussion. At 9:15 the bell rang, and the students were dismissed.

Anthony did not walk around the class while students were working independently to monitor their progress. Once again, he began the class discussion prior to all students completing the class assignment. He did not utilize instructional strategies other than asking a few close-ended questions to motivate the students to participate in the discussion; nor did he inform students listening to their music to turn off their music.

Table 4.2

EQUIP Scores of Anthony's Second Classroom Observation

Factors	Construct Measured	Score
	Instructional Strategies	1
	Order of Instruction	1
Instructional	Teacher Role	1
	Student Role	1
	Knowledge Acquisition	1
Instructional Comprehensive Score		1
	Questioning Level	1
	Complexity of Questions	1
Discourse	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	1
Discourse Comprehensive Score		1.4
	Prior Knowledge	1
	Conceptual Development	1
Assessment	Student Reflection	1
	Assessment Type	1
	Role of Assessing	1
Assessment Comprehensive Score		1
	Content Depth	2
	Learner Centrality	1

Curriculum	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.3
Overall View of the Lesson		1

Observation three. The topic of the third observation was Female Reproduction (see table 4.3 for an explanation of the EQUIP scores). Instructions written on the board were similar to the instructions given in previous observations and included A) pages 996 - 1000; B) define key terms; C) copy and answer key ideas; D) answer question number five page 1000; and E) answer quick lab numbers one through four page 1000. The class consisted of nine students, six males and three females.

Anthony began class by stating the assignment written on the board while seated at his desk. Once instructions were given, students immediately began the assignment while Anthony took attendance. As students who were late for class entered the classroom, Anthony gave them their folder, explained the instructions, and the students obtained a textbook before sitting down to complete the class work. After ten minutes, Anthony read question number five and then proceeded to explain the female hormones progesterone and estrogen. One female student asked “Is it possible to have children back to back?” and Anthony answered her question. Anthony then continued the discussion by reading and discussing the next question. While Anthony discussed the information, he asked several questions. However, the students did not respond to his questions nor did they participate in the discussion by asking additional questions.

Thirty minutes into the class period, Anthony began to discuss women requiring iron in their diets and suggested that they cook with cast iron cookware to increase their iron levels. He also mentioned that female athletes who have low body mass index or who are below normal body weight often do not ovulate. Anthony then related the subject to it being an evolutionary way to prevent pregnancy at a young age. Now that he had captured the attention of one female student, she asked “So you are saying that girls can’t get pregnant at a young age?” To answer her question, Anthony gave an example of a 9 year old girl in Brazil who recently gave birth to a healthy child. During the meantime, students continued to complete the class work independently at their desks, and once they were finished the assignment, they placed the paper inside their folders, and then placed their folders on Anthony’s desk.

Anthony continued the lesson by asking the questions, “Why do periods hurt? Why do some women have more painful periods than other women?” He then used the LCD projector to show an image of a uterus and related the pain felt by some women to fibroid tumors. He then continued to explain fallopian tubes and ectopic pregnancies. The female student who participated in the discussion previously asked about in vitro fertilization. While Anthony answered her question, the bell rang and students were dismissed.

Table 4.3

EQUIP Scores of Anthony’s Third Classroom Observation

Factors	Construct Measured	Score
	Instructional Strategies	1
	Order of Instruction	1

Instructional	Teacher Role	1
	Student Role	2
	Knowledge Acquisition	1
Instructional Comprehensive Score		1.5
Discourse	Questioning Level	1
	Complexity of Questions	1
	Questioning Ecology	2
	Communication Pattern	3
	Classroom Interactions	2
Discourse Comprehensive Score		1.8
Assessment	Prior Knowledge	1
	Conceptual Development	1
	Student Reflection	1
	Assessment Type	1
	Role of Assessing	1
Assessment Comprehensive Score		1
Curriculum	Content Depth	1
	Learner Centrality	1
	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1
Overall View of the Lesson		1

Instructional style. Anthony EQUIP's scores identified him on the inquiry continuum as pre-inquiry. During his three observations, the class was undeniably teacher centered; students sat passively and listened to him as he lectured on various topics. Even though Anthony asked questions in an attempt to facilitate group discussions, the questions were at the knowledge/remembering level and did not require higher order thinking skills. Additionally, twenty percent or fewer of the students responded to Anthony's questions. Anthony asked several questions during each observation to stimulate students' interest; however, once they initially participated in the engagement questions, their interest in the topic quickly waned as Anthony proceeded to discuss the topic in more detail. Students worked independently during each of the three observations to complete assigned tasks in the textbook. Once students completed and submitted their class work assignments, the majority of them either conversed with one another or listened to their music. Anthony taught all three lessons while seated at his desk; he did not walk around the classroom to monitor students' progress on the class work assignments. Anthony did not inform students that they were not allowed to listen to their music while the class discussion occurred. Nor did he try to prevent students from participating in individual conversations during the class discussions.

Focus group. The focus group conducted with Anthony's students consisted of seven individuals, four males and three females. Once students understood the purpose of the questions, they were eager to participate and spoke freely about their experiences in science classes at the previous comprehensive high school they attended, as well as their experiences in their current alternative education high school biology class. When asked to compare their current alternative education science class to the science class they previously attended at the comprehensive high school, one female student stated "Well, the teacher at the alternative education high school looks out for you, he treats you like everyone else and he shows a video to explain what we're learning about. Like every single time we go to a different chapter, he always shows us a video of what we're learning about. When we ask him a question, he actually answers us." Another female student stated "The class size is not as big as a comprehensive high school class; our class size here is less than 20 kids; it's more one on one interaction between the student and teacher." A male student added, "I like it here, it's a lot different. However, I'm used to hands-on and doing stuff, but now every day I come here and do the same book work and it's kind of boring; that's what I don't like about this science class." Another male student stated, "We had a lab at the comprehensive high school, but we don't have a lab here."

When asked about instructional methods used by Anthony to teach science, one female responded "All we do is video and book work." When asked to elaborate on the book work, a female answered, "It's the same questions, he tells you to define the key terms, key ideas, and to answer the five section review questions." When asked if they enjoyed completing the book work, a female answered "It's cool cause it's easy, but it's the same stuff every day." When asked if they would prefer book work or hands-on investigations, two males and one female answered almost simultaneously "hands-on." Another male elaborated, "But sometimes book work prepares you for hands-on." When asked what Anthony does to motivate you to learn science, one male student answered "He's humorous sometimes." A female student stated "He's really a genuine teacher, like he really wants to help us; at the comprehensive high school you just pass on your own."

Anthony's students participated in many hands-on investigations at the comprehensive high school they attended prior to enrolling at the alternative education high school. However, they did not conduct any type of inquiry investigations at the alternative education high school they were currently attending. They did not complete group activities nor did they use computers to research topics.

The students preferred the smaller class size at the alternative education high school and realized that Anthony was able to provide more individualized instruction as a result of the smaller class size. During the observations, several students asked Anthony a question pertaining to the assignment, even though he did not move away from his desk to assist the student, he did stop whatever task he was completing to answer the student's question. Students also recognized that the small class size allowed them to develop more of a relationship with Anthony. The students acknowledged the fact that Anthony is concerned about them being successful in his class. They all agreed that they do not like the daily book assignments which do not motivate them to learn science.

Nancy

Nancy, a white female age 30 – 39, taught biology at a suburban alternative education high school in Northern California which employed 14 teachers. She had 14 years of teaching experience, a Bachelor of Science Degree in Biology, a Master of Education Degree, and passed a licensing examination to become a teacher. Nancy held three California Clear Single Subject Teaching Certificates which certified her to teach Introductory Science, Health Science, and Biological Science. Nancy, who was the only science teacher employed at her alternative education high school, did not prepare instructional materials with other science teachers; nor did she discuss how to teach particular concepts with other science teachers. Science teachers were not given the opportunity to observe her teaching practices nor did she observe the teaching practices of other science teachers. During the past two years, Nancy participated in professional development regarding integrating technology into science, improving students' critical thinking or inquiry skills, and science assessment. However, she did not participate in professional development concerning science content, science pedagogy, or science curriculum.

Nancy's students had access to a class set of laptop computers located on a computer cart and access to the internet. When asked about her availability of necessary laboratory equipment, Nancy replied "My laboratory equipment is pretty limited. I have a personal network with science teachers who work at the comprehensive high schools within my district, and I borrow materials from them when necessary." When asked what strategies she uses to motivate students to learn science, Nancy responded, "I relate the material to their daily lives which gives automatic by-in from the students. I have a personal relationship with my students, and they trust me. I try to make learning fun, not dry. I use different teaching methods. My students are parents, they enjoy learning genetics, and they want to know what will happen to their children.

School. The school enrolled a total of 126 students. The ethnicity of the student population included 23% Hispanic or Latino, 2% American Indian or Alaska Native, 3% Asian, 2% Filipino, 6% African American, 62% White, and 2% Two or More Races. Seventeen percent of the student population was considered socioeconomically disadvantaged. Of the 126 students, one was in the ninth grade, 11 were in the tenth grade, 31 were in the eleventh grade, and 83 were in the twelfth grade. The school day consisted of six periods and a 20 minute brunch which lasted from 10:50 am to 11:10 am. First period began at 8:30 and lasted fifty minutes. The other five periods were 45 minutes in length and school ended at 1:25. Students enrolled at the alternative education high school also had the option to participate in independent study, home schooling, or attend a separate program for expecting parents. The school offered many of the major courses to include physical science, biology, health, general math, algebra, geometry, California High School Exit Examination (CAHSEE) math, English, CAHSEE English, history, US History, government, economics, art, cooking, physical education, and special education.

C**lassroom.** Nancy taught biology in a small classroom which did not have space for students to conduct laboratory investigations. However, the space was equipped with four tables (three rectangular and one circular), a sink, and two storage cabinets. The teacher's desk was located in the left corner of the back of the classroom, and there were two white boards, one in the front of the classroom and the other on the side of the classroom opposite the windows. Two of the rectangular tables were connected and placed directly in front of the whiteboard which is where instruction primarily occurred and where Nancy sat as she taught the class. Nancy had an LCD projector and a laptop computer placed on a rolling cart in front of the whiteboard which was used to show science videos.

Observation one. The topic of the lesson for Nancy's first observation was meiosis, and the class consisted of five female students (see table 4.4 for an explanation of the EQUIP scores). The lesson began with a five minute warm up activity in which Nancy discussed haploid versus diploid cells. The lesson proceeded with students using a microscope to observe meiosis in prepared slides of a bird ovary, mouse ovary, and sperm cells. The students worked individually due to the small class size and the number of microscopes and prepared slides not being a limitation. Nancy noticed that several students immediately switched to the high power objective instead of beginning with the scanning objective, and stopped to instruct them in the proper use of the microscope. Once students located the cells, they drew the various phases of meiosis under high power. While observing the cells, one student paused to ask, "What happens when you donate your body to science, will the person remember your memories if you donate your brain?" Nancy answered the student, and the class continued to draw their observations. A few minutes later, another student asked, "Is pink the actual color of our cells?" Nancy replied, "No, the cells have been dyed to allow you to observe them." Once students completed their drawings, answered their questions, and returned the materials and equipment to the storage area, class was dismissed.

Table 4.4

EQUIP Scores of Nancy's First Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	3
	Order of Instruction	1
	Teacher Role	2
	Student Role	3
	Knowledge Acquisition	2

Instructional Comprehensive Score		2.2
Discourse	Questioning Level	2
	Complexity of Questions	2
	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	2
Discourse Comprehensive Score		2
Assessment	Prior Knowledge	1
	Conceptual Development	2
	Student Reflection	1
	Assessment Type	2
	Role of Assessing	2
Assessment Comprehensive Score		1.6
Curriculum	Content Depth	2
	Learner Centrality	2
	Integration of Content and Investigations	3
	Organizing and Recording Information	1
Curriculum Comprehensive Score		2
Overall View of the Lesson		2

Observation two. The topic of the second observation was gene mutations (see table 4.5 for an explanation of the EQUIP scores). The biology class consisted of four female students and two additional female students were working independently at a separate table. Class began with a ten minute discussion of start and stop codons. Then, students were given a mutations worksheet, and Nancy explained the directions to the class. After directions were given, Nancy proceeded to explain the various types of mutations and solved a few examples with the class. Once everyone seemed to understand, the students took turns reading the questions and solving the type of mutation. After a few of the mutations were discussed, one student stated “Nancy, I don’t understand the letters.” Nancy referred the students back to the mRNA codons chart and explained how to interpret the chart.

Nancy asked the class if they knew what sickle cell anemia is. No one responded, so she asked the question again. One student responded, “That’s when you don’t make enough red blood cells.” Nancy replied, “Not exactly,” and explained how it occurs. Another student asked, “Why does it occur in mostly African Americans?” Nancy continued the discussion by relating malaria in Africa to sickle cell. She explained that the sickle cell trait prevented malaria causing the trait to become prevalent in the population because individuals without the trait died. After the explanation, she told a student to put her phone away and stop texting in class.

Then Nancy told the students to look back at the worksheet and asked, “How does normal differ from sickle?” A student responded, “CTT is normal and CAT is sickle.” Then Nancy said, “What is that called? Look back at the first page.” A student replied, “Substitution”. Nancy then wrote a segment of DNA on the board and instructed the students to write the corresponding RNA and the resulting amino acids.

Nancy continued the class discussion by drawing a diagram of DNA on the whiteboard and illustrating how it unzips. She then illustrated the pairing of RNA with different marker colors. Nancy reminded students that “U” replaces “T” in RNA. After the discussion, students continued to complete the remainder of the worksheet independently. Once the bell rang, students submitted their assignments and were dismissed.

Table 4.5

EQUIP Scores of Nancy’s Second Classroom Observation

Factors	Construct Measured	Score
	Instructional Strategies	2
	Order of Instruction	1
Instructional	Teacher Role	2
	Student Role	3
	Knowledge Acquisition	3
Instructional Comprehensive Score		2.2
	Questioning Level	3
	Complexity of Questions	2
Discourse	Questioning Ecology	3
	Communication Pattern	2
	Classroom Interactions	2
Discourse Comprehensive Score		2.4
	Prior Knowledge	1
	Conceptual Development	3

Assessment	Student Reflection	1
	Assessment Type	1
	Role of Assessing	3
Assessment Comprehensive Score		1.8
	Content Depth	3
	Learner Centrality	2
Curriculum	Integration of Content and Investigations	3
	Organizing and Recording Information	1
Curriculum Comprehensive Score		2.3
Overall View of the Lesson		2.2

Observation three. The topic of Nancy's third observation was transcription and translation, and the class consisted of four females (see table 4.6 for an explanation of the EQUIP scores). During this particular observation, Nancy had an agenda written on the board. Students completed the warm-up activity within the first five minutes of class. Once they completed the warm-up activity, they were given a mutations worksheet which they completed independently within ten minutes. While students completed the worksheet, Nancy monitored them and asked questions to ensure they were on task and understood the assignment. Nancy asked one student "What did the insertion do?" The student replied, "It shifted." Nancy said, "Correct, it created a frame shift." One student was unable to identify the change in the sequence and asked for assistance. Nancy walked over to the student and explained that the mutation did not change the resulting proteins and, therefore, is a silent mutation. After all students completed the worksheet, the correct answers were discussed. Nancy selected one student to read the first question and state her answer. Nancy asked if anyone had questions pertaining to the correct answer, and no one responded. Nancy then informed another student to read the next question and state her answer. The discussion of the correct answers lasted 15 minutes, and Nancy elaborated on problems the students did not understand. Class continued with the students playing mutation bingo, which they enjoyed immensely.

Table 4.6

EQUIP Scores of Nancy's Third Classroom Observation

Factors	Construct Measured	Score
	Instructional Strategies	2
	Order of Instruction	1
Instructional	Teacher Role	1
	Student Role	2
	Knowledge Acquisition	2
Instructional Comprehensive Score		1.6
	Questioning Level	3
	Complexity of Questions	3
Discourse	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	2
Discourse Comprehensive Score		2.8
	Prior Knowledge	1

	Conceptual Development	2
Assessment	Student Reflection	1
	Assessment Type	1
	Role of Assessing	2
Assessment Comprehensive Score		1.4
Curriculum	Content Depth	2
	Learner Centrality	2
	Integration of Content and Investigations	2
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.8
Overall View of the Lesson		1.9

Instructional style. The EQUIP scores of Nancy's three observations placed her as developing inquiry on the inquiry continuum. The three observations were primarily teacher-centered; however, the students were actively engaged during the majority of each lesson, and Nancy served as both lecturer and as a facilitator of knowledge. The students explored concepts in one lesson, and Nancy explained concepts in the other two lessons. The learning in each observation focused on mastery of facts and process skills without much focus on understanding the content. Even though the students completed an activity which required the use of a microscope, the purpose of the activity was to verify what they learned previously about the phases of meiosis.

Nancy controlled the class discussions, but students participated in the discussions and often asked questions pertaining to their daily lives which were relevant to the learning. Questions asked during the discussions rarely challenged students above the understanding level and were primarily close-ended questions. Two of the lessons began with a warm-up activity, which Nancy used to assess students' prior knowledge. The lessons provided some depth of content, but there were no connections made to the big picture to ensure conceptual understanding. Only one lesson included student investigation that linked well with the content. Nancy did not circulate around the classroom; however, it was not necessary because her class size was extremely small and she sat at the table with her students. The students were well behaved during each observation.

Focus group. The focus group with Nancy's students consisted of six female students grades eleventh through twelfth. Of the six students, one student participated in an independent study alternative education program before being enrolled in Nancy's alternative education school, one student moved to the area from Mexico, and each of the other four students came from different comprehensive high schools.

The students participated in several hands-on activities at the comprehensive high schools, and they enjoyed the activities. However, they disliked the fact that the activities extended past the class period and often extended into their lunch time. They only participated in a few hands-on activities at the alternative education high school they currently attended. Students agreed that they did not enjoy completing book work but liked working together in groups to complete book assignments. Students completed several projects which required internet research. During one of the projects, each student was assigned a genetic disease; they researched the disease, created a brochure, and shared the brochure with the class. One student stated “I enjoyed the research project because it was on the computer; we weren’t using the textbook, so it was more interesting using the computer.”

The alternative education school had smaller class sizes which allowed the teacher to interact with each student and develop relationships with the students. The small class size also allowed Nancy to review concepts with individual students as necessary until they fully understood the idea. Students mentioned that they could discuss various topics with Nancy including life, personal situations, and their boyfriends. One student stated that “Nancy is open with us, so we try to be open with her too.” Another student stated “We all have our own personal relationship with Nancy; it makes you want to come to school and learn. She is a good teacher.” The relationships between the students and Nancy served as a motivational factor for the students to learn science. They realized that Nancy actually cared about whether or not they were successful in her class. Nancy also tried to motivate her students by relating the learning to their daily lives. One student stated that about 98% of what they learn in biology relates to their daily lives which motivated her to learn science.

Lisa

Lisa, an African American female between the ages of 25 – 29, had three years of teaching experience, earned a Bachelor of Science Degree in Biology, was in the process of obtaining a Master of Education Degree, and held a California Single Subject Probationary Certificate in Biological Science which would be clear by the end of the school year. She taught two biology classes and three Earth science classes at an urban alternative education high school in Northern California which employed eight teachers. Lisa discussed with her colleagues almost daily the preparation of instructional materials and how to teach a particular concept. She did not have the opportunity to visit the classrooms of other science teachers to observe their teaching practices nor did other science teachers observe her teaching practices. During the past two years Lisa participated in science professional development pertaining to content, pedagogy, assessment, and curriculum. Lisa described her availability of necessary laboratory equipment as limited. In response to what strategies she used to motivate students to learn science, Lisa stated, “I give real world connections to science concepts. I show films to reinforce science concepts and create or plan labs that are relevant to science concepts being taught.”

School. The school enrolled a total of 148 students ages 16 through 18 and was composed of 39% Hispanic or Latino, 0.7% Asian, 1.4% Pacific Islander, 0.7% Filipino, 57% African American, and 0.7 % Not Reported. Eighty-six percent of the student population was considered socioeconomically disadvantaged. Of the 148 students enrolled, five were in the tenth grade, 38 were in the eleventh grade and 105 were in the twelfth grade. The school day consisted of six periods and a 20 minute lunch. Period one was 50 minutes in length and the other five periods were 45 minutes long. First period began at 9:00 am, and sixth period ended at 3:28 pm. All core classes (math, science, social studies, and ELA) were offered in the morning between 9:00 am and 12:36 pm. The school offered many of the major courses to include Earth science, biology, general math, algebra, geometry, California High School Exit Examination (CAHSEE) math, English I, English II, English III, English IV, CAHSEE English, US

History, World History, culture, government, economics, physical education, and special education.

Classroom. Even though Lisa was not assigned to a science classroom, she did have six laboratory tables and a tile floor. Four students sat at each laboratory table, two in the center and one on each end. Three regular student desks were placed in the back of the classroom along with a rectangular shaped table. The classroom did not have a sink or laboratory safety equipment. Lisa had a white board in the front of the classroom and an overhead projector. The teacher's desk was placed on the far left wall between storage cabinets and several file cabinets. Students' folders were stored on a table placed in the front right corner of the classroom.

Observation one. The topic of Lisa's first observation was sexually transmitted diseases (see table 4.7 for an explanation of the EQUIP scores). The class consisted of seven students, four males and three females. The learning targets written on the whiteboard included 1) I can identify parts of mitosis and 2) I can define HIV and STD's and provides examples of STD's. The agenda written on the board included:1) warm-up STD's; 2) matching activity; 3) STD symptom notes; and 4) study guide pages 43-46.

As students entered the class, Lisa explained the warm-up activity and passed out the classwork packet. Once the students settled down, they completed the warm-up activity as Lisa took attendance. A few minutes later, Lisa sent a student to the board to write the name of a sexually transmitted disease caused by a bacterium. Then another student was sent to the board to write the name of another sexually transmitted caused by a bacterium. The class continued with a discussion of HIV, and only two students (one male and one female) were not engaged. Lisa used the overhead projector to show a table which listed the names of several sexually transmitted diseases. As a class, the students indicated the mode of transmission of each sexually transmitted diseases and the photo number which corresponded to the correct image of the sexually transmitted disease. During the remainder of the class period, students completed the sexually transmitted diseases packet individually, and after fifteen minutes class was dismissed.

Table 4.7

EQUIP Scores of Lisa's First Classroom Observation

Factors	Construct Measured	Score
	Instructional Strategies	2
	Order of Instruction	1
Instructional	Teacher Role	2
	Student Role	2
	Knowledge Acquisition	2
Instructional Comprehensive Score		1.8
	Questioning Level	1
	Complexity of Questions	1
Discourse	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	2
Discourse Comprehensive Score		1.6
	Prior Knowledge	1
	Conceptual Development	1
Assessment	Student Reflection	1

	Assessment Type	1
	Role of Assessing	2
Assessment Comprehensive Score		1.2
Curriculum	Content Depth	2
	Learner Centrality	2
	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.5
Overall View of the Lesson		1.5

Observation two. Observation two involved the discussion of sexually transmitted diseases and six students were present (see table 4.8 for an explanation of the EQUIP scores). Students were divided into two groups. The first group was given a set of blue (fluids) and orange (body opening) cards and was told to match the fluid to the body opening. The second group was given photos of sexually transmitted diseases and a list of the names of several sexually transmitted diseases. Group two was informed to match the photo to the name of the sexually transmitted disease. Once the materials were disseminated to each group, Lisa explained the instructions again because the students were uncertain of the directions.

While the groups completed the assignment, Lisa walked around the classroom, monitored each group, and assisted as necessary. During the assignment one student stated, “Why do we keep talking about diseases?” Another student stated, “This is hella nasty. Why do we have to do this?" In response to the students, Lisa explained, "If you are sexually active, you need to know this information." A student stated, "Don't if you have one of these for too long you can get a PID." Lisa explained that sexually transmitted diseases may cause pelvic inflammatory disease and prevent a woman from having children. After ten minutes of completing the assignment, the two groups exchanged cards and completed the other half of the assignment. As students continued to match the items, the lesson continued with Lisa discussing herpes for five minutes. Lisa explained that herpes can be treated and that most people do not show symptoms until the second stage.

While Lisa explained herpes in further detail, the students simply listened; they did not ask questions or participate in the discussion. Lisa did not ask the students questions to engage them in the conversation; she simply continued to talk as they matched the items. During the lesson, a few students got off task, but Lisa was able to re-engage them by showing and discussing another photo. Even though the students complained about the assignment and did not want to view images of individuals with sexually transmitted diseases, they completed the assignment with minimal resistance.

Table 4.8

EQUIP Scores of Lisa's Second Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	2
	Order of Instruction	1
	Teacher Role	3
	Student Role	2

	Knowledge Acquisition	2
Instructional Comprehensive Score		2
Discourse	Questioning Level	2
	Complexity of Questions	2
	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	1
Discourse Comprehensive Score		1.8
Assessment	Prior Knowledge	1
	Conceptual Development	2
	Student Reflection	1
	Assessment Type	2
	Role of Assessing	1
Assessment Comprehensive Score		1.4
Curriculum	Content Depth	2
	Learner Centrality	2
	Integration of Content and Investigations	2
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.8
Overall View of the Lesson		1.8

Observation three. Six students, three males and three females, were present in class during observation three, and the title of the lesson was Monohybrid Crosses (see table 4.9 for an explanation of the EQUIP scores). The learning target, “I can identify different genotypes of alleles,” was written on the board. As students entered the class, they were instructed to turn their music off and place their Punnett Squares worksheet on the desk. Class began with Lisa informing the students to read the article on the front of the paper and answer questions one through four. Then Lisa drew a monohybrid cross on the board, listed the parental alleles, and combined the alleles in each box. One male student participated in the class discussion and explained the phenotypes and genotypes of the resulting offspring. Lisa continued the lesson by explaining the difference between heterozygous and homozygous and she related the prefixes homo and hetero to the words heterosexual and homosexual. Next, Lisa told a student to complete box one on the worksheet, and the student asked, “Why are they both yy?” Lisa explained the genotype and the student completed the box. Lisa continued to discuss the monohybrid crosses to the students who listened while constantly telling the students who were not on task to calm down. After fifteen minutes, students were placed in groups of three and given a Sponge Bob worksheet to complete as independent practice. While Lisa read the instructions and explained the worksheet, the majority of the students participated in individual conversations, and only one student seemed to listen to the directions. After instructions were given, Lisa admonished one student for listening to his music too loudly and another student stated, “We only have fifteen minutes left.” While the students completed the Sponge Bob worksheet, Lisa continued to instruct the class and walked around to each group to monitor their progress. Once students completed the assignment, they placed the papers inside their folders and placed the folder on Lisa's desk. The bell rang and class was dismissed.

Table 4.9

EQUIP Scores of Lisa's Third Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	2
	Order of Instruction	1
	Teacher Role	2
	Student Role	2
	Knowledge Acquisition	2
Instructional Comprehensive Score		1.8
Discourse	Questioning Level	1
	Complexity of Questions	2
	Questioning Ecology	2
	Communication Pattern	2
	Classroom Interactions	1
Discourse Comprehensive Score		1.6
Assessment	Prior Knowledge	1
	Conceptual Development	1
	Student Reflection	1
	Assessment Type	1
	Role of Assessing	2
Assessment Comprehensive Score		1.2

Curriculum	Content Depth	2
	Learner Centrality	2
	Integration of Content and Investigations	2
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.8
Overall View of the Lesson		1.6

Instructional style. Lisa's EQUIP scores categorized her as developing inquiry. All three of her observations were primarily teacher-centered. Students displayed medium attention to the lesson and students were actively engaged and on task the majority of the class period. Each lesson was focused on students mastering facts without much focus on understanding the content. Students explored concepts during group activities, but the exploration occurred after explanations were given.

Lisa primarily asked close-ended knowledge based questions, and she typically controlled and directed the class communication. She answered students' questions but failed to engage the students in teacher/student discussions. Students were observed discussing amongst themselves during the sexually transmitted diseases group assignments and the discussions pertained to the learning.

Lisa assessed students' prior knowledge in only one of the lessons. The independent and group activities completed by students measured only factual knowledge. Each lesson provided some depth of content, but Lisa failed to make connections to the big picture. While students completed their group activities, Lisa circulated around the classroom to ensure students remained on task and evaluated their progress.

There were a few students who were admonished during the lessons for failure to complete the assignment, listening to music too loudly, or answering a phone call during class. However, the majority of the students was well behaved, remained in their desks throughout the class period, and respected Lisa. The students were also respectful in their interactions with one another.

Focus group. Lisa's focus group was conducted with only two seniors, one male and one female and both students attended the alternative education high school for seven months. Unfortunately, students in the other grade levels were completing a district assessment and were unavailable to participate in the focus group. When asked what they liked about the science class at the comprehensive high school, the male student responded, "Actually, I never really liked the class, I cut class often, but I remember doing one experiment that made me interested in biology. We did an experiment how to find DNA in a fruit, and I remember seeing the DNA and it looked like a thread." When asked to explain the difference between the science class at the comprehensive high school and the science class at the alternative education high school, the male student stated, "The classes here are definitely smaller and the teacher focuses on you more." In response to the most productive instructional strategy for them to learn science, the female responded, "Do experiments and take notes." In response to the same question the male student replied, "Doing hands-on activities and a lot of experiments."

Both students agreed that the alternative education school's class size was much smaller than the comprehensive high school's class size. The smaller class size allowed

Lisa to provide the students individualized instruction when necessary. They also agreed that conducting hands-on investigations and completing projects were the most productive strategies for them to learn science. They completed class assignments in cooperative groups several times a week but rarely conducted hands-on investigations.

Lisa developed relationships with her students which made her aware of when they were in a foul mood. She would give the students necessary space during class and later would converse with the student to determine how she could assist them to solve their issues. Lisa also allowed students to come to her classroom during their free time to complete missing assignments and improve their grades. As a result of the relationship Lisa built with her students, the students were concerned enough about their science grade to actually complete the missing assignments.

Robert

Robert, a white male age 40-49, had four years of teaching experience and held a provisional teaching certificate which would be clear by the end of the school year. He earned a Bachelor of Science Degree in Anthropology, took several graduate classes in biology, and passed the Biology and Physics licensing examinations to earn a California Single Subject Provisional Teaching Certificates in Biology and Physics. Robert taught two biology classes and two conceptual physics classes at a suburban alternative education high school in Northern California which employed ten teachers. During the past two years, Robert participated in a variety of science professional development to include content, curriculum, improving critical thinking or inquiry skills, and assessment. In response to the availability of necessary laboratory equipment, Robert replied, “I have a limited budget, and I purchased several materials last year. I am reimbursed for materials I purchase on my own; I simply need to provide the receipt. I am able to borrow from the comprehensive high school teachers when necessary. Also, there are several laboratory companies in the area which donate old equipment and glassware to teachers when they purchase new materials." When asked how he motivates students to learn science, Robert answered, "I take the students outside to do labs whenever possible. The best unit I taught was an electricity unit. The students completed hands-on investigations every day, which increased their motivation."

School. The school enrolled a total of 80 students ages 16-18 and was composed of 36% Hispanic or Latino, 2.5% Asian, 1.25% Pacific Islander, 1.25% Filipino, 6.3% African American, 51% White, and 1.25% Two or More Races. Twenty-eight percent of the student population was considered socioeconomically disadvantaged. Of the 80 students enrolled, seven were in tenth grade, thirty-two were in eleventh grade and fourty-one were in twelfth grade. Students enrolled at the school also had the option to participate in independent study or home study. The school day consisted of five periods 45 minutes in length, a 45 minute intervention period, and a 30 minute lunch. First period began at 8:48 am and fifth period ended at 1:48 pm. The school offered all of the major courses to include: Earth science, biology, health, general math, algebra, geometry, California High School Exit Examination (CAHSEE) math, English 9, English 10, English 11, English 12 CAHSEE English, journalism, history, civics, economics, culture, multimedia, art, ceramics, leadership, physical education, and special education.

Classroom. Robert's classroom was recently renovated and contained five laboratory tables. Four students sat on lab stools at each laboratory table, two in the center and one on each end. A demonstration table with a sink was located in the front of the classroom. The teacher's desk was located in the front left corner of the classroom. A computer desk with two computers was located in the front right corner of the classroom. Cabinets were located on the far left wall and across the back wall. Additionally, four sinks and an eye wash station were located on the back wall. A fire extinguisher and a fire blanket were also located inside the classroom. The LCD projector was mounted to the ceiling, and a white board was placed in the center of the front wall.

Observation one. The topic of the first observation was the Central Dogma of Biology and the class consisted of eight students, six females and four males (see table 4.10 for an explanation of the EQUIP scores). As students entered the class, they were informed to answer the kick off question which was projected onto the whiteboard. The kick off question was 1) What is RNA? 2) What does it do? 3) How is it related to DNA? Students worked independently for the first five minutes of class to answer the kick off question, and Robert walked around the classroom to ensure that students answered the question. While the students answered the question, one male student stated that he had the answer, and Robert informed him to wait until his classmates were finished answering the question. After the students were given sufficient time to answer the kick off question, Robert explained what DNA is and where it is located. A female student asked, "What is RNA"? Robert briefly explained that DNA becomes RNA and RNA becomes protein. Then he mentioned the terms transcription and translation and informed students that the standard for today was transcription and translation which would be discussed in great detail.

As Robert explained the kick off question, only one female student responded to him by asking a question about RNA. The other students sat passively and listened to him as he lectured. Robert did not allow the male student who stated earlier that he had the answer an opportunity to explain his answer, nor did the male student volunteer to answer the question again.

Robert continued the discussion by asking the question, “What is Morse code?” No one answered the question; however, one student made the clicking sound of Morse code using his mouth to make the sounds. Robert continued to explain that each sound in Morse code represents a letter while making the actual sounds. He then related the Morse code to the Titanic and the entire class listened attentively. Robert continued the discussion by explaining that DNA is also a code. A student said, “That’s how they connect because DNA is also a code.” Robert then showed a diagram of DNA and explained its structure. Next, he showed the class one of the paper DNA models they made in a previous lesson. Then he showed a video which illustrated how DNA unwinds and is copied. One student asked, “Robert, is that how it really happens?” He replied, “This is a simplified version, but yes. Robert then asked, “What is the molecule that pulls it apart?” A student responded “polymerase.” Robert continued to probe the student until he answered correctly.

The class continued with a discussion of nucleotides. Robert showed a diagram of a nucleotide and asked, “What do the letters represent,” and the students answered correctly. All of the students were attentive to the class discussion and most of them participated in the discussion. Robert continued the class by differentiating between DNA and RNA, showed a video of transcription, and explained the process. Next, he showed a video of translation, explained the process of translation, and made the learning relevant by relating the topic to sickle cell anemia. The discussion ended with a conversation of mutations. The last five minutes of the class were utilized by students writing in their learning logs.

Table 4.10

EQUIP Scores of Robert's First Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	3
	Order of Instruction	2
	Teacher Role	3
	Student Role	3
	Knowledge Acquisition	3
Instructional Comprehensive Score		2.8
Discourse	Questioning Level	2
	Complexity of Questions	2
	Questioning Ecology	3
	Communication Pattern	3
	Classroom Interactions	2
Discourse Comprehensive Score		2.4
Assessment	Prior Knowledge	4
	Conceptual Development	3
	Student Reflection	3
	Assessment Type	3
	Role of Assessing	3
Assessment Comprehensive Score		3.2

Curriculum	Content Depth	3
	Learner Centrality	2
	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1
Overall View of the Lesson		1.75

Observation two. The topic of observation two was DNA extraction (see table 4.11 for an explanation of the EQUIP scores) and twelve students, four males and eight females, were present in class. Class began with students being informed to answer the kick off question which was the first slide of the PowerPoint presentation. The kick off question asked whether the following statement was true or false and required students justify their answer in one or two sentences. The presence of dark colored volcanic rock caused the mutation for black fur to appear in the rock pocket mouse population. As students answered the question, Robert walked around the classroom to monitor their progress and assess their answers. He asked probing questions of students who were unable to answer the question independently until they selected the correct answer. Once everyone had an opportunity to answer the question, Robert asked the students to raise their hands if they thought the answer was true, and one student raised his hand. Robert then told the students to raise their hand if they thought the answer was false, and five students raised their hands. Robert proceeded to explain mutations and how they occur by drawing a flow chart on the board which illustrated the process. In explaining the process of mutations, Robert related mutations which allow an individual to survive in its environment to natural selection.

Class continued with Robert asking, “Has anyone ever extracted their DNA?” The class sat quietly. He proceeded by asking, “Where is DNA located?” Next, the students attentively watched a video which explained the process of DNA extraction of cheek cells. Once the video ended, Robert informed the class that they would follow the procedure in the video with slight modifications. Robert gave each student a Dixie cup and passed out the procedure which was discussed in detail. He informed the students that he prepared the salt water and demonstrated how to add the soap. Then he explained why the alcohol is cold and demonstrated how to add the alcohol properly to the test tube.

The students rinsed their mouths with salt water and then chewed on their cheeks to remove the cheek cells. One female student stated, “This is gross.” Another student stated, “I can’t do this; I’m going to do it over the sink.” Even though many of the students complained, they still gargled to prepare their cheek cells. After gargling, the students spit into their Dixie cups, added soap, and poured the mixture into their vials. Robert then poured alcohol into each vial and the students waited patiently for the DNA to appear while answering the lab questions. Once the DNA was visible, the students were fascinated and began to compare their DNA to the DNA of other students. Robert then gave each student a small vial and allowed the students to transfer their DNA into the small vial to take home. By the time students cleaned their laboratory tables, the bell rang, and they were dismissed.

Table 4.11

EQUIP Scores of Robert's Second Classroom Observation

Factors	Construct Measured	Score
Instructional	Instructional Strategies	3
	Order of Instruction	3
	Teacher Role	3
	Student Role	3
	Knowledge Acquisition	3
Instructional Comprehensive Score		3
Discourse	Questioning Level	3
	Complexity of Questions	3
	Questioning Ecology	3
	Communication Pattern	3
	Classroom Interactions	3
Discourse Comprehensive Score		3
Assessment	Prior Knowledge	2
	Conceptual Development	2
	Student Reflection	1
	Assessment Type	1
	Role of Assessing	1
Assessment Comprehensive Score		1.4
	Content Depth	3
	Learner Centrality	2

Curriculum	Integration of Content and Investigations	3
	Organizing and Recording Information	3
Curriculum Comprehensive Score		2.75
Overall View of the Lesson		2.84

Observation three. The purpose of observation three was to review for an assessment (see table 4.6 for an explanation of the EQUIP scores). Six students, one male and five females were present during the observation. The lesson began with the class watching an animated video of Homer Simpson evolving through time from one type of animal into another. After the video, students were informed to answer the kick off question. The kick off question asked students what they thought the film said about evolution.

After students were given five minutes to answer the kick off question, Robert asked the class,” what do you think about the video, and two female students responded. One of the students summarized what occurred in the video and stated, “Cells evolved into fish, fish evolved into dinosaurs, and dinosaurs evolved into cavemen. Robert then asked the class, “Can a person evolve.” No one responded to the question. Robert waited for almost a minute and then continued to explain that individuals do not evolve, populations evolve over time. He explained how a mutation in an individual’s genes is passed down to their offspring and that the offspring become subject to the mutation.

Then Robert placed the students into groups of three and passed out review questions to study for the chapter test. While students answered the review questions, Robert walked around the room to monitor their progress and assisted them as needed. Most students were on task the entire class period; however, when students started talking amongst themselves, Robert immediately informed them to get back on task. After thirty minutes, the class discussed the questions and the correct answers by each student receiving an opportunity to read a question and state their answer. Robert praised students when they answered the questions correctly and probed the class when a student answered the question incorrectly until the correct answer was given. The bell rang and students were dismissed.

The entire class attentively watched the video and answered the kick off question. However, only two students participated in the discussion and shared their thoughts on the video. Robert asked several questions to engage students in the discussion, but he only waited a few seconds before answering the question himself. The answering of the kick off question and discussion that followed lasted the first ten minutes of class.

Table 4.12

EQUIP Scores of Robert's Third Classroom Observations

Factors	Construct Measured	Score
	Instructional Strategies	3
	Order of Instruction	2
Instructional	Teacher Role	3
	Student Role	3
	Knowledge Acquisition	2
Instructional Comprehensive Score		2.4
	Questioning Level	3

Discourse	Complexity of Questions	3
	Questioning Ecology	3
	Communication Pattern	3
	Classroom Interactions	3
Discourse Comprehensive Score		3
Assessment	Prior Knowledge	2
	Conceptual Development	3
	Student Reflection	3
	Assessment Type	3
	Role of Assessing	3
Assessment Comprehensive Score		2.8
Curriculum	Content Depth	3
	Learner Centrality	2
	Integration of Content and Investigations	1
	Organizing and Recording Information	1
Curriculum Comprehensive Score		1.75
Overall View of the Lesson		2.49

Instructional style. Robert's EQUIP scores identified his instructional style as proficient inquiry. Of the four classrooms, his class was the most student-centered, and he frequently acted as a facilitator. Robert lectured, but he also used engaging videos and real world scenarios to explain the content. His students were active learners; most were involved in the discussions, the investigation, and the group activities. Hs students were able to apply what they previously learned to new concepts.

When students answered a question incorrectly, he did not inform them that they were incorrect and then answer the question himself. Instead, Robert asked probing questions until students replied correctly. Robert began each class period with a kick off question which was used as a catalyst to start class discussions. Additionally, he used the students' responses to the kick off question to direct instruction. Each of Robert's kick off questions required students to think critically by explaining relationships between various concepts and justifying their thoughts. In the last observation, students were able to reflect upon their learning from the past few weeks to answer review questions in preparation for the chapter test. Robert provided depth of content when teaching about replication, transcription, and translation and connected it to the big picture, the central dogma. Robert also connected mutations to natural selection.

Focus group. The focus group conducted with Robert's students included eight individuals, three students were sophomores, three were juniors, and the other two students were seniors. When asked to compare the science class at the comprehensive high school to the science class at the alternative education high school, one female stated, "We did more labs at the comprehensive high school." Another student added, "We did labs at least once a week at the comprehensive high school."

Students agreed that the alternative education school's class sizes were much smaller than their class sizes at the comprehensive high school. This allowed Robert to provide individualized instruction when needed. Robert allowed students to come back for extra assistance after school, and he gave them chances to complete missed assignments.

One female student described Robert as very patient and understanding. A male student said, “Because he’s so patient, he makes sure you understand the concepts prior to moving forward.” Another female added, “Robert makes sure we understand the information before we take tests, so we don’t automatically fail.” They felt comfortable enough with Robert to freely ask questions in class, and Robert always responded. Robert’s patience and concern for his students to be successful in his class motivated his students to complete their assignments.

Robert’s students participated in at least one hands-on activity per chapter. They described several recent hands-on activities they completed in class including extracting their DNA; making DNA models using paper to illustrate replication, transcription, and translation; and a predation activity. They preferred watching science videos, hands-on investigations and group projects to simply completing bookwork as motivational strategies to learn science. The class discussions also motivated them to learn science. None of the students in the focus group identified science as their favorite subject, two of the students disliked science, and the other students stated that science is in the top three of their favorite subjects. They all agreed that they enjoy learning science when the content is relevant to their daily lives.

Major Themes

Several themes emerged from the qualitative data: limited materials, real world relevancy, and caring teacher-student relationships. Each teacher expressed that he/she did not have the necessary laboratory materials and equipment to allow their students to complete hands-on investigations on a regular basis. Of the four teachers, Robert was the only teacher in a laboratory science classroom. Anthony, Nancy, and Lisa were assigned to regular classrooms. Anthony and Lisa did not have sinks in their classrooms, and Anthony and Nancy did not have laboratory tables in their classrooms. However, Nancy at least had four tables; Anthony only had regular student desks. Robert was the only teacher to have laboratory safety equipment in his classroom, which consisted of an eye wash station and fire extinguisher.

Nancy and Robert were the only teachers who were able to borrow equipment from the comprehensive high school teachers. Robert recently received school funds to purchase laboratory materials. Additionally, Robert recently received materials from laboratory companies interested in donating materials to K-12 public schools.

All of the students stated that they participated in more hands-on activities at the comprehensive high schools. Additionally, each focus group discussed the lack of hands-on activities at the alternative education high schools and stated that more opportunities to participate in hands-on activities would increase their motivation to learn science. However, none of the students related the lack of hands-on opportunities to their teacher’s lack of necessary materials and equipment.

As a result of the teachers not having access to laboratory materials and equipment that would have enabled them to regularly incorporate hands-on investigations, they relied more heavily on bookwork and videos to enhance conceptual development, which created teacher-centered classrooms. Of the four teachers, Anthony was the most teacher-centered, and Robert was the least teacher-centered. Nancy, Lisa, and Robert allowed students to explore concepts; however, the exploration always occurred after explanations were given and the activities were primarily for verification purposes only. Robert’s and Nancy’s students participated in a hands-on investigation; however, the investigations were teacher directed.

Anthony’s students worked independently in each of the observations to complete book assignments. During the focus group, students discussed their dislike of bookwork and wanting more opportunities to participate in group assignments and project based activities. Students agreed that they enjoyed watching science videos to enhance conceptual learning. Anthony and Robert regularly incorporated videos into instruction; however, Robert’s videos were more instructional, more relevant to the learning, and promoted conceptual understanding while Anthony’s videos were simply obtained online from various sites and did little to explain the concepts in further detail.

Each teacher stated that they regularly related the learning to students’ daily lives to motivate them to learn science. This real world relevancy was witnessed in the classroom observations of each teacher. Students became more engaged in the classroom discussions when the learning was relevant to their daily lives or real world connections were given. The students recognized the real world connection of biology to their daily lives and understood that relevancy was a motivational factor for them to learn science.

Caring relationships were established between each teacher and their students. Nancy explicitly stated that the relationship between she and her students allows her students to trust her. Students stated that they had a relationship with their alternative education high school science teacher and that their teachers were genuinely concerned with them being successful in their classes. Even though the students did not prefer their teachers’ direct instructional style and in some instances complained about the book assignments, they still completed their daily tasks due to their relationships with their teachers. The relationships which existed between the teachers and their students were also a motivational factor for students to learn science. Additionally, the students respected their teachers due to their teacher-student relationship. Teachers were able to build relationships with their students due to the small class sizes. The students preferred the small class size at the alternative education high school because it enabled them to interact with their science teacher on an individual basis.

Teachers' Second Interview

Teachers participated in a second phone interview after the qualitative data were analyzed to further investigate themes which emerged from the qualitative data. Teachers shared additional insights into their teaching practices by explaining why they taught in a particular manner. They discussed academic and life goals they wanted their students to achieve and mentioned situations which would prevent students from attaining the goals. Teachers discussed the effectiveness or ineffectiveness of their teaching strategies in addition to citing reasons which would prevent students from learning. Additionally, teachers explained whether they thought their teaching methods motivated students to learn science and improved students' attitudes toward science while providing justification for their answers.

Anthony. A typical day in Anthony's classroom began with no more than five minutes of lecture. The lecture was followed by students completing an assignment independently or cooperatively. The last five minutes of class, Anthony discussed information which pertained to the class assignment.

Anthony's life goals for his students were for them to earn enough credits to graduate from high school and eventually obtain a job. Anthony's curriculum was based on the California science standards and his academic goals were for his students to have a fundamental knowledge of the standards. Anthony also wanted his students to be aware of how the standards intersected with their daily lives. For students who were unable to obtain the goals, Anthony worked closely with their parents or guardians and school counselors to assist them in becoming successful in the classroom.

Anthony's instructional strategies included one-on-one direct instruction and classroom discussions. Anthony found his teaching methods to be effective for a large proportion of his students. Evidence of Anthony's effective instructional strategies included the increased graduation rate from 30- 40 % to 80 – 90 % within the nine year time period in which he was employed by the alternative school. Anthony cited language difficulties due to the large English Language Learner population, family or community problems, or being a special needs student as some of the reasons students were unable to learn despite his best teaching efforts. Some students were uninterested in learning because they discovered another path to follow such as gang membership or drug sales.

Anthony found some of his students to be interested in the aspect of science itself. He stated, "A great deal of science teaching is the memorization of facts." He believed his students were motivated to learn science due to the type of questions they posed during daily discussions and the manner in which they were able to make connections between various content topics.

Anthony believed that caring teacher-student relationships were very important for the alternative education student population. He also found it necessary to be nonjudgmental of his students. Anthony stated “Every day is a new day. They know they will not be judged for what happened in the past. They have to own up to their mistakes and be responsible for them. However, it does not change how I view them in the classroom.”

Nancy. There were no typical days in Nancy’s classroom due to her teaching in alternative education. The truancy rate was extremely high for her students, and, therefore, she was unaware of who would attend class on a regular basis. Some of Nancy’s students had huge educational gaps and many of her students were English Language Learners, which required differentiation of instruction to meet the needs of all learners.

Nancy’s curriculum was based on the California science standards and her academic goals included students passing the state science assessment and gaining knowledge of biology which could be used outside of the classroom. Her instructional strategies included collaborative assignments, individual research, textbook assignments, lecture, and her students maintained a journal. Evidence of Nancy’s effective instructional strategies included student feedback and verbal checks for understanding. When students did not understand the learning, Nancy used a different instructional approach to re-teach. Issues which prevented students from learning despite Nancy’s efforts were due to students’ basic needs not being met. Nancy stated “Their brains can only handle so much if they are not feeling safe or are not fed. They are not able to focus on biology terminology, it just is not going to happen. If their basic needs are not met, I cannot get through to them educationally.”

Nancy felt her less structured, nonlinear approach to teaching science made learning science more desirable, thus motivating her students to learn. By providing positive learning experiences, Nancy's students did not realize they were actually learning. Nancy also motivated students by teaching small chunks of information at a time which allowed students to immediately feel successful.

Lisa. Lisa's students arrived to class approximately five to ten minutes late on a regular basis. The first few minutes of class were dedicated to students completing a Do Now assignment. The Do Now was used to review concepts from a previous class period or to access students' prior knowledge of new concepts. Students knew to immediately obtain their folder and complete the Do Now assignment when they arrived to class.

Lisa's goals for her students were for them to be able to think critically about various science concepts, articulate various science concepts, and work in cooperative groups to improve their ability to work as a team. Students who were not able to attain the goals were paired with a more successful student. Lisa also allowed students to return after class for additional individualized assistance.

Lisa used a claim, evidence, reasoning rubric to improve students' critical thinking skills. Students would generate a claim to answer a question. Then students reviewed articles and watched science videos to find evidence to support their claim. Next, they provided reasoning to connect the evidence to the claim. Students were able to write wonderful summary arguments; therefore, Lisa found the instructional strategy to be effective. Lisa incorporated music in the form of songs and raps to help students learn vocabulary. To help the English Language Learners learn vocabulary, Lisa showed images which represented the terms.

Many of Lisa's students dealt with negative home situations which prevented them from learning. Some students were addicted to drugs or alcohol, other students dealt with issues related to their girlfriends or boyfriends, and many of the students grieved the loss of friends to violence. Even though there were many obstacles which prevented students from learning, Lisa felt as though she was able to motivate her students to learn science and improved their attitudes toward science. Lisa used a real world approach to motivate her students by connecting what they learned in class to their daily lives. She created a classroom community, and she cared deeply about her students being successful in school and graduating. Lisa stated, "I really do care about my students; I really do care about their achievements and walking the stage. If they do not graduate, I am afraid for how they may end up in the future."

Robert. A typical day in Robert's class consisted of eight to fifteen students actively engaged in hands-on activities and class discussions. The California science standards were the basis of Robert's curriculum, but that was not his main emphasis. Robert's goals were for his students to be interested in learning in general and to think critically. Robert often allowed students to research and investigate topics they were interested in. He used simulations and songs to help students learn, and he re-taught necessary concepts to ensure all students learned.

Robert believed his instructional strategies were effective based upon conversations with his students and test results. Students were engaged in the class, applied what they learned to other contexts, and were willing to go above and beyond. However, students' home life, personal situations, and truancy rate often prevented them from learning.

Research question 1: How do teachers' beliefs about student learning relate to their pedagogy?

Teacher Self efficacy

Anthony. As indicated in Table A.1, Anthony scored 118 on the TSES meaning he possessed a high self-efficacy. Of the seven TSES subscales, Anthony scored highest on the efficacy to influence decision making subscale indicating that he believed he could greatly influence decisions made at his school and that he could feely express his views on important school matters as shown in Table A.2. Anthony scored lowest on the efficacy to enlist community involvement subscale, which indicated that he had little influence on getting community groups, churches, businesses, and local colleges and universities involved in working with the school.

Anthony also scored high (94) on the STEBI-A, which indicated he possessed high science teaching efficacy beliefs in general as shown in Table A.3. Of his STEBI-A score, Anthony's scored 59 on the personal science teaching efficacy beliefs scale (PSTE) and scored 35 on the science teaching outcome expectancy scale (STOE) indicating a difference of 24 points between the two scales. His scores illustrate the fact that he had high confidence in his ability to teach science but had lower belief that student learning can be influenced by effective teaching. Additionally, this meant that Anthony did not believe that his confidence in his ability to teach science would have a positive impact on the outcome of his science students. Of the four teachers, Anthony possessed the lowest EQUIP scores, yet his means on the STEBI-A and TSES were higher than the means of the other teachers. The results from the EQUIP scores, focus groups, TSES, and STEBI-A indicate that Anthony was confident with his science content and confident as a traditional teacher; however, he was not effective at changing student learning as indicated by his low science teaching outcome scores.

Nancy. Nancy's mean score of 92 on the TSES, (see Table A.1), indicated she possessed a low teacher self-efficacy. She scored highest on the efficacy to create a positive school climate subscale as indicated on Table A.2. This signified that Nancy believed she has some influence to make her school a safe place, to make students enjoy coming to school, and to get students to trust her. Nancy created a safe, trusting environment which encouraged students to attend school by forming positive relationships with her students as indicated in the focus group. Nancy's lowest score was earned on the efficacy to enlist parental involvement subscale. She believed that she had very little influence on getting parents to become involved in school activities, assisting parents in helping their children do well in school, and making parents feel comfortable coming to school.

Table A.3 illustrates Nancy's mean score of 85 on the STEBI-A, which indicated she possessed low science teaching efficacy beliefs in general. Of the four teachers, Nancy scored the lowest on the STEBI-A. Nancy's mean score on the PSTE scale (47) was greater than her mean score on the STOE scale (38) of the STEBI-A. This illustrated that she possessed high confidence in her ability to teach science but possessed lower belief in the fact that student learning could be influenced by her effective teaching. The difference between her PSTE score and her STOE score was 9 points.

Lisa. Lisa's TSES mean score was 84, which indicated she possessed a low teacher self-efficacy as shown in Table A.1. However, she earned the lowest score on the TSES of the four teachers, which could be contributed to her having only three years of teaching experience. Of the TSES subscales, Lisa scored highest on the efficacy to influence decision making subscale, which indicated that she could influence decisions that are made at her school and that she could feely express her views on important school matters as indicated in Table A.2. She scored lowest on the efficacy to influence school resources subscale, indicating that she had very little control over obtaining needed instructional materials and science equipment as specified in her teacher interview.

Lisa’s mean score on the STEBI-A was 87, which indicated low science teaching efficacy beliefs in general as shown in Table A.3. Her mean score on the PSTE scale of 45 was the lowest of all four PSTE scores. However, her mean score of 42 on the STOE was the highest of all four scores. Additionally, her 3 point difference between the mean scores on the PSTE scale and the STOE scale was the lowest of the four teachers. This indicated that Lisa believed student learning could be influenced by effective teaching.

Robert. Robert scored 92 on the TSES, which indicated a low teacher self-efficacy (Table A.1). Of the TSES subscales, he scored highest on the efficacy to influence decision making subscale and the efficacy to influence school resources subscale (Table A.2). This indicated Robert believed that he could influence decisions made at his school and that he could feely express his views on important school matters (Table 9). Robert influenced school resources by obtaining donated laboratory equipment from area laboratories. He scored lowest on the instructional self-efficacy subscale. This indicated that Robert felt he had very little to some control over class size. Additionally, he had very little to some influence on getting through to the most difficult students, promoting learning when there is a lack of support from home, and keeping students on task on difficult assignments.

Robert's mean score was 87 points on the STEBI-A, which included a mean of 51 on the PSTE and a mean 36 on the STOE (Table A.3). There was a 15 point difference between his PSTE mean and the STOE mean. His scores indicated that he also possessed low science teaching efficacy beliefs in general. Robert's scores also showed that he had a higher confidence in his ability to teach science than his belief that students' learning could be influenced by his effective teaching.

Bandura's Instrument Teacher Self-efficacy Scale

Collectively, the teachers earned the highest mean score of 4.0 indicating *quite a bit of influence* on five of the TSES questions (see Table 4.13). The questions, "how much can you influence the decisions that are made in the school" and "how much can you express your views freely on important school matters," were components of the efficacy to influence decision making subscale. All four teachers believed that they could voice their opinion on school matters and that their opinions would be taken into consideration. The questions how much can you do to get children to follow classroom rules and how much can you do to control disruptive behavior in the classroom are in the disciplinary self-efficacy subscale. Each teacher dealt with disruptions during the observations; however, the disturbances were minor and the individual student causing the disruption quickly complied with the teacher's request to cease the inappropriate behavior. The question, "how much can you do to make the school a safe place," is the only question in the efficacy to create a positive school climate subscale to receive a mean score of 4.0. The level of respect observed between each teacher and their students and between the students themselves as they interacted with one another during the observations was evidence of the teachers maintaining positive school climate within their classrooms.

The lowest TSES mean scores were earned on four questions (Table 4.13). Three of the questions were related to instructional self-efficacy: how much can you do to influence the class sizes in your school; how much can you do to overcome the influence of adverse community conditions on students' learning; and how much can you do to get children to do their homework? The alternative school administrators determine the class size. However, the alternative education class sizes were much smaller than the comprehensive high school class sizes as indicated by the students during the focus groups. The teachers believed they were unable to get churches involved in working with the school, and they were unable to overcome the influence of adverse community conditions. The teachers felt as though they were unable to get the students to complete homework, which is why the alternative high schools had a no homework policy.

Table 4.13

Means and Standard Deviations from Bandura's Instrument Teacher-Self-Efficacy Scale (5 = A Great Deal to 1 = Nothing)

Survey Item	Mean	Standard Deviation
How much can you influence the decisions that are made in the school?	4.0	0.82
How much can you express your views freely on important school matters?	4.0	0.82

How much can you do to get the instructional materials and equipment you need?	3.25	0.96
How much can you do to influence the class sizes in your school?	2.0	.82
How much can you do to get through to the most difficult students?	3.5	1.0
How much can you do to promote learning when there is lack of support from the home?	3.5	.58
How much can you do to keep students on task on difficult assignments?	3.25	.50
How much can you do to increase students’ memory of what they have been taught in previous lessons?	3.25	.50
How much can you do to motivate students who show low interest in schoolwork?	3.25	.50
How much can you do to get students to work together?	3.50	.58
How much can you do to overcome the influence of adverse community conditions on students’ learning?	2.25	.50
How much can you do to get children to do their homework?	2.25	.50
How much can you do to get children to follow classroom rules?	4.0	.82
How much can you do to control disruptive behavior in the classroom?	4.0	.82
How much can you do to prevent problem behavior on the school grounds?	3.50	.58

How much can you do to get parents to become involved in school activities?	2.50	.58
How much can you assist parents in helping their children do well in school?	3.0	.82
How much can you do to make parents feel comfortable coming to school?	3.25	.50
How much can you do to get community groups involved in working with the schools?	3.0	.82
How much can you do to get churches involved in working with the school?	2.25	.96
How much can you do to get businesses involved in working with the school?	2.75	.5
How much can you do to get local colleges and universities involved in working with the school?	3.25	.5
How much can you do to make the school a safe place?	4.0	1.16
How much can you do to make students enjoy coming to school?	3.50	.58
How much can you do to get students to trust teachers?	3.25	.50
How much can you help other teachers with their teaching skills?	3.50	1
How much can you do to enhance collaboration between teachers and the administration to make the school run effectively?	3.0	.82
How much can you do to reduce school dropout?	3.0	.82
How much can you do to reduce school absenteeism?	3.0	.0

How much can you do to get students to believe they can do well in schoolwork?	3.75	.96

Science Teaching Efficacy Belief Instrument

The teachers earned the highest STEBI mean scores on five statements (see Table 4.14). Each of the five statements which earned the highest mean scores was on the PSTE subscale. Teachers answered the statement, “I understand science concepts well enough to be effective in teaching elementary science,” with a mean score of 4.5 which indicated *agree.* All four teachers felt confident in their knowledge of science content and participated in various types of science professional development within the last two years. Additionally, all four teachers earned Bachelor of Science Degrees in Biology. Teachers *agreed* to the statement, “When teaching science, I usually welcome student questions.” It was apparent from the observations that the students felt comfortable enough with their teachers to ask questions. Additionally, the focus groups provided evidence which indicated that the relationships built between the teachers and their students also created a classroom environment which made it comfortable for students to ask questions. Teachers also *agreed* to the statement, “I am typically able to answer students' science questions.” During the observations, students asked various questions which the teacher was able to answer. The statement, “Given a choice, I would not invite the principal to evaluate my science teaching,” was negatively worded and received a mean score of 4.25 meaning the teachers *disagreed* with the statement. Each teacher was confident in his/her science knowledge and, therefore, would welcome being evaluated by his/her administrator. The statement, “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” was negatively worded and earned a mean score of 4.25 meaning they *disagreed* with the statement. The teachers were confident in their pedagogical skills and felt as though they could explain various science concepts to allow students to understand.

The teachers earned the lowest STEBI mean scores on four statements. Of the four statements, three statements were on the STOE subscale. The statement, "If students are underachieving in science, it is most likely due to ineffective science teaching," earned a mean score of 1.75 meaning the teachers *disagreed.* The teachers believed that factors other than their ineffective teaching practices were the reason that their students would underachieve in their class. The teachers indicated a mean score of 2.5 meaning they *agreed* with the statement, "Even teachers with good science teaching abilities cannot help some kids learn science." They *agreed* with the statement, "The low science achievement of some students cannot generally be blamed on their teachers." They *agreed* with the statement, "I don't know what to do to turn students on to science."

Table 4.14

Means and Standard Deviations from the Science Teaching Efficacy Belief Instrument (5 = Strongly Agree to 1 = Strongly Disagree)

Survey Item	Mean	Standard Deviation
When a student does better than usual in science, it is often because the teacher exerted a little extra effort.	3.75	0.50
I am continually finding better ways to teach science.	3.25	1.50
Even when I try very hard, I don't teach science as well as I do most subjects.	4.25	0.50

When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.	3.75	0.50
I know the steps necessary to teach science concepts effectively.	3.75	0.50
I am not very effective in monitoring science experiments.	3.50	1.29
If students are underachieving in science, it is most likely due to ineffective science teaching.	1.75	0.50
I generally teach science ineffectively.	3.50	0.58
The inadequacy of a student's science background can be overcome by good teaching.	4.00	0.00
The low science achievement of some students cannot generally be blamed on their teachers.	2.75	0.96
When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.	3.50	0.58
I understand science concepts well enough to be effective in teaching elementary science.	4.50	0.58
Increased effort in science teaching produces little change in some students' science achievement.	3.00	1.15
The teacher is generally responsible for the achievement of students in science.	3.00	0.82
Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3.00	0.82
If parents comment that their child is showing more interest in	3.75	0.50

science at school, it is probably due to the performance of the child's teacher.		
I find it difficult to explain to students why science experiments work.	4.00	0.82
I am typically able to answer students' science questions.	4.25	0.50
I wonder if I have the necessary skills to teach science.	3.75	0.96
Effectiveness in science teaching has little influence on the achievement of students with low motivation.	3.00	1.15
Given a choice, I would not invite the principal to evaluate my science teaching.	4.25	0.50
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.	4.25	0.50
When teaching science, I usually welcome student questions.	4.50	0.58
I don't know what to do to turn students on to science.	2.75	1.50
Even teachers with good science teaching abilities cannot help some kids learn science.	2.50	1.00

The results of the STEBBI scores reiterated the results of the second interview. Teachers earned the highest mean scores on the PSTE subscale. The second interview indicated teachers believed their instructional strategies were effective and that the strategies motivated most of their students to learn science. However, each teacher’s STOE scores were several points lower than their PSTE scores. The teachers did not believe that their effective instruction could overcome their students’ negative situations.

Despite their best teaching efforts, they were still unable to reach some of their students. During the second interview, teachers contributed this to the fact that students are unable to learn if their basic needs are not met.

CHAPTER 5

ALTERNATIVE EDUCATION STUDENT FINDINGS

This chapter focuses on the quantitative data collected from the four teachers' classrooms and consists of three surveys: Constructivist Learning Environment Survey, Science Motivation Questionnaire, and the Scientific Attitude Inventory. Students completed the Constructivist Learning Environment Survey (CLES) to determine their perception of the degree of constructivism practiced in the classroom. Students completed the Science Motivation Questionnaire (SMQ), created by Glynn and Koballa (2005), to determine how motivated they were to learn science. Students completed the Scientific Attitude Inventory (SAI II), by Moore and Foy (1997), to determine how their attitudes toward science differed based on the teacher's instructional style.

Constructivist Learning Environment Survey

The CLES consisted of 34 questions with five response options from almost always (5) to almost never (1). The CLES measured students' perception of the actual classroom environment and their preferred classroom environment. The survey is composed of six scales: personal relevance, science uncertainty, student negotiation, investigation, involvement, and cooperation.

Students' mean scores and standard deviations were calculated for each question for the actual version and the preferred version (Table 5.1). Students earned the highest mean scores of the actual version on questions 6, 21, and 27. Students selected: I *often* learn that scientific explanations have changed over time (μ = 4.05); the teacher *often* asks me questions (μ = 4.05); and I *often* cooperate with other students when doing assigned work (μ = 4.0). Students earned the lowest mean scores of the actual version on questions 17, 11, 14, and 15. Students selected: I *seldom* carry out investigations to answer questions that puzzle me (μ = 2.41); I *seldom* ask other students to explain their ideas (μ = 2.50); I *seldom* explain the meaning of statements, diagrams, and graphs (μ = 2.55); and I s*eldom* carry out investigations to answer teacher's questions (μ = 2.55).

Students earned the highest mean scores of the preferred version on questions 4, 27, and 32. Students selected: I *often* learn interesting things about the world in and outside of school (μ = 3.95); I *often* cooperate with other students when doing assignment work (μ = 4.0); and I *sometimes to often* cooperate with other students on class activities (μ = 3.77). Students earned the lowest mean scores of the preferred version on questions 12, 14, and 15. Students selected: I am *seldom to sometimes* asked by others to explain my ideas (μ = 2.77); I *seldom* explain the meaning of statements, diagrams, and graphs (μ = 2.77); and I *seldom* carry out investigations to answer teacher's questions (μ = 2.86).

Table 5.1

Means and Standard Deviations from the Constructivist Learning Environment Survey (5 = almost always to 1 = almost never)

Survey Item	Think Mean	Think Standard Deviation	Prefer Mean	Prefer Standard Deviation
1. I learn about the world outside of school.	3.27	.94	3.59	1.10

2. New learning relates to experiences or questions about the world in and outside of school.	3.45	.91	3.45	1.14
3. I learn how science is a part of my in- and outside-of-school lives.	3.50	1.26	3.32	1.39
4. I learn interesting things about the world in and outside of school.	3.50	1.37	3.95	.84
5. I learn that science cannot always provide answers to problems.	3.5	1.10	3.18	1.05
6. I learn that scientific explanations have changed over time.	4.05	.84	3.77	1.19
7. I learn that science is influenced by people's cultural values and opinions.	2.77	1.48	3.05	1.25
8. I learn that science is a way to raise questions and seek answers.	3.32	1.17	3.41	1.40
9. I talk with other students about how to solve problems.	2.68	1.32	3.09	1.38

10. I explain my ideas to other students.	2.91	.92	3.32	1.87
11. I ask other students to explain their ideas.	2.50	1.23	2.95	1.13
12. I'm asked by others to explain my ideas.	2.68	1.36	2.77	1.15
13. I carry out investigations to answer questions coming from discussions.	3.0	1.27	3.0	1.02
14. I explain the meaning of statements, diagrams, and graphs.	2.55	1.10	2.77	1.27
15. I carry out investigations to answer teacher's questions.	2.55	1.30	2.86	1.32
16. I find out answers to questions by doing investigations.	2.64	1.26	2.95	1.17
17. I carry out investigations to answer questions that puzzle me.	2.41	1.18	3.09	1.19
18. I solve problems by using information obtained from my own investigations.	2.86	1.32	3.41	1.10
19. I discuss ideas in class.	3.27	1.32	3.41	1.30
20. I give my opinions during class	3.41	1.10	3.77	.92

discussions.				
21. The teacher asks me questions.	4.05	.78	3.50	1.19
22. My ideas and suggestions are used during classroom discussions.	3.27	1.12	3.27	1.08
23. I ask the teacher questions.	3.50	1.26	3.59	1.30
24. I explain my ideas to other students.	2.77	1.15	3.09	1.27
25. Students discuss with me how to go about solving problems.	2.59	1.18	3.18	1.18
26. I am asked to explain how I solve problems.	3.45	1.06	3.14	1.04
27. I cooperate with other students when doing assignment work.	4.0	1.13	4.0	1.11
28. I share my book and resources with other students when doing assignments.	3.77	1.07	3.59	1.26
29. I work with other students on projects in this class.	3.23	1.31	3.64	1.09
30. When I work in groups in this class, there is teamwork.	3.50	1.34	3.64	1.56
31. I learn from other students in this class.	2.95	1.21	3.45	1.22

32. I cooperate with other students on class activities.	3.77	1.19	4.05	1.13
33. Students work with me to achieve class goals.	2.91	1.34	3.36	1.26
34. I work with other students in this class.	3.36	1.33	3.82	1.05

Students' preferred and actual mean scores and standard deviations were calculated and compared for each of the six subscales (Table 5.2). Students preferred a more constructivist classroom environment than was actually present in all six subscales with the exception of the science uncertainty subscale. Students earned the greatest mean difference on the student negotiation (0.35) and investigation subscales (0.35) (Table 5.2). Students preferred a classroom learning environment that allowed them an opportunity to explain and justify their ideas to classmates, listen to the ideas of other classmates, and reflect on their own ideas. They also preferred an environment that allowed them to conduct more investigations and related the learning experiences to their daily lives.

Table 5.2

Means and Standard Deviations from the Constructivist Learning Environment Survey for Each Subscale

Survey Item	Think Mean	Think Standard	Prefer	Prefer Standard	Think and Prefer Mean

		Deviation	Mean	Deviation	Difference
Personal Relevance	3.43	0.96	3.58	0.97	0.15
Science Uncertainty	3.41	0.69	3.35	0.93	-0.06
Student Negotiation	2.69	1.0	3.04	1.03	0.35
Investigation	2.67	0.98	3.02	0.97	0.35
Involvement	3.29	0.84	3.37	0.91	0.08
Cooperation	3.44	1.01	3.70	1.03	0.26

A one-way repeated measures ANOVA was calculated comparing students' actual and preferred perception of the classroom environment (Table 5.3). No significant effect was found F (2 , 19) = 2.32, p>.05. No significant difference exists among think (m = 107.95, sd = 25.93) and prefer (m = 114.45, sd = 29.31). The repeated measures also indicated no significant interaction was found for think and prefer with instructional style F(2, 19) = 1.39, p>.05. A significant effect was found interacting with instructional style between subjects for think and prefer F (2, 19) = 3.69, p<.05.

Table 5.3

Repeated Measures Analysis of Variance for the Constructivist Learning Environment Survey

Source	df	F	p
Between Subjects			
Think x Prefer x Instructional Style	2	3.691*	.044

Within Subjects			
Think x Prefer	1	2.32	.144
Think x Prefer x Instructional Style	2	1.39	.273

*p < .05.

A multiple comparison was calculated due to the interaction with instructional style for think and prefer to determine which pairs were significantly different. A significant difference was found for think comparing the Pre-Inquiry instructional style to the Developing Inquiry instructional style (p = .023) (Table 5.4). Thus, students of teachers who incorporated more inquiry based instruction thought their actual classroom environment included more constructivist based activities than students whose teachers did not incorporate more inquiry based instruction.

Table 5.4

Multiple Comparisons of Instructional Styles for the Constructivist Learning Environment Survey

Dependent Variable	(I) Style	(J) Style	Sig.
Think	1	2	*.023
		3	.119
	2	1	*.023
		3	.567
	3	1	.119
		2	.567

Prefer	1	2	.173
		3	.096
	2	1	.173
		3	.969
	3	1	.096
		2	.969

*p < .05.

Figure 5.1 illustrates the increase in the means for actual and preferred for instructional styles one and three and a decrease in means for actual and prefer for instructional style two. Students in Anthony’s and Robert’s classes preferred a more constructivist environment than was actually present. However, students in Nancy’s and Lisa’s classes preferred a less constructivist environment than was actually present. The figure also shows an interaction for preferred classroom environment between instructional styles two and three. The interaction for the preferred classroom environment is due to the increase in means from actual to preferred for Anthony’s students and the decrease in means from actual to preferred for Nancy’s and Lisa’s students. All students indicated that relevancy of learning, caring teacher-student relationships, and integration of inquiry based investigations was necessary to motivate them to learn science and improve their attitudes toward science. However, the decrease in actual and preferred means for Nancy’s and Lisa’s students on the CLES may indicate that relevancy of learning and caring teacher-student relationships may be more necessary than the integration of inquiry based investigations to motivate them to learn science and improve their attitudes toward science.

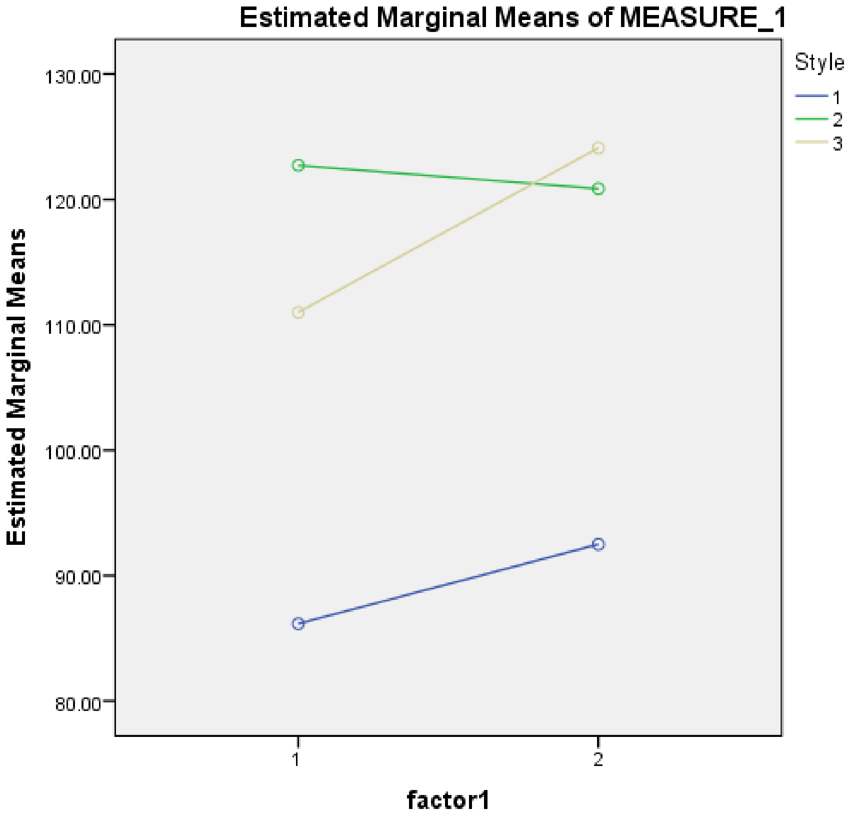

Figure 5.1

Interaction of Instructional Style between Actual and Preferred Classroom Environments

Overall, students preferred a more constructivist classroom environment than was actually present in the case study classrooms. Additionally, students preferred a more constructivist classroom environment than was actually present for five of the six subscales. A significant difference was found for the actual classroom environment between the Pre-Inquiry instructional style and the Developing Inquiry instructional style indicating a significant difference in the amount of inquiry based instruction between the two instructional styles.

Research Question 2: How is students' motivation to learn science influenced by the teachers' pedagogy?

Science Motivation Questionnaire

Evidence of students' motivation to learn science was discovered using the SMQ. The six factors measured by the questionnaire are intrinsically motivated science learning; extrinsically motivated science learning; personal relevance of learning science; self-determination (responsibility) for learning science; self-efficacy (confidence) in learning science; and anxiety about science assessment. The anxiety about science assessment scale is negatively scored, so a higher score on this scale indicates less anxiety. The maximum score on the questionnaire is 150 and the minimum score is 30. Students who score from 30 to 59 are *never to rarely* motivated to learn science, 60–89 are *rarely to sometimes* motivated to learn science, 90–119 are *sometimes to often* motivated to learn science, and 120–150 are *often to always* motivated to learn science.

Students' mean scores and standard deviations were calculated for each question (Table 5.5). Students earned the highest mean scores on questions 7 (extrinsically motivated science learning subscale), 14 (anxiety about science assessment subscale), and 30 (intrinsically motivated science learning subscale). Students indicated that earning a good science grade is *usually* important to them (µ = 4.21). Students are *sometimes to rarely* concerned that other students are better in science than themselves (µ = 3.76). Students indicated, "Understanding the science gives me a sense of accomplishment" *sometimes to usually* (µ = 3.68).

Questions 10 (extrinsically motivated science learning subscale), 20 (self –determination subscale), and 26 (self –determination subscale) received the lowest mean scores. Students indicated that they *rarely to sometimes* prepare well for science tests and labs (µ = 2.75). Students selected they *rarely to sometimes* think about how learning the science can help them get a good job (µ = 2.55). Students selected it is *rarely* their fault, if they do not understand the science (μ = 2.46) meaning they hold their teacher accountable to ensuring that they understand the learning.

Table 5.5

Means and Standard Deviations from the Science Motivation Questionnaire (5 = Always to 1 = Never)

Survey Item	Mean	Standard Deviation
1. I enjoy learning the science.	3.31	.89
2. The science I learn relates to my personal goals.	2.90	1.29
3. I like to do better than the other students on the science tests.	3.14	1.25
4. I am nervous about how I will do on the science tests.	3.18	1.22
5. If I am having trouble learning the science, I try to figure out why.	3.55	1.24
6. I become anxious when it is time to take a science test.	3.59	1.15
7. Earning a good science grade is important to me.	4.21	.98
8. I put enough effort into learning the science	3.76	.87
9. I use strategies that ensure I learn the science well.	3.03	.98
10. I think about how learning the science can help me get a good job.	2.55	1.21
11. I think about how the science I learn will be helpful to me.	2.90	1.18
12. I expect to do as well as or better than other students in the science course.	3.31	1.11

13. I worry about failing the science tests.	2.83	1.20
14. I am concerned that the other students are better in science.	3.76	1.21
15. I think about how my science grade will affect my overall grade point average.	3.29	1.30
16. The science I learn is more important to me than the grade I receive.	2.71	.94
17. I think about how learning the science can help my career.	2.89	1.26
18. I hate taking the science tests.	2.93	1.36
19. I think about how I will use the science I learn.	3.00	1.22
20. It is my fault, if I do not understand the science.	2.46	1.17
21. I am confident I will do well on the science labs and projects.	3.64	.78
22. I find learning the science interesting.	3.61	1.03
23. The science I learn is relevant to my life.	2.86	1.11
24. I believe I can master the knowledge and skills in the science course.	3.25	1.04
25. The science I learn has practical value for me.	2.86	1.11
26. I prepare well for the science tests and labs.	2.75	.89
27. I like science that challenges me.	2.86	1.18
28. I am confident I will do well on the science tests.	3.25	.93
29. I believe I can earn a grade of “A” in the science course.	3.50	1.0

30. Understanding the science gives me a sense of accomplishment.	3.68	1.28

Each of the five subscales on the SMQ has a minimum score of five and a maximum score of 25, with a total of five questions per subscale. The mean scores and standard deviations for each subscale were divided by five to represent individual questions. Students scored highest on the personal relevance of learning science subscale (μ= 4.52) (Table 5.6). Students scored the lowest on the extrinsically motivated science learning subscale (μ= 3.23)

Table 5.6

Means and Standard Deviations from the Science Motivation Questionnaire for Each Subscale (Calculated per Number of Questions per Subscale)

Subscale	Mean	Standard Deviation
Intrinsically motivated science learning	3.24	0.80
Extrinsically motivated science learning	3.23	0.87
Personal relevance of learning	4.52	0.73
Self- determination (responsibility) for learning science	3.98	0.57
Self –efficacy (confidence) in learning science	3.40	0.63
Anxiety about science assessment	3.26	0.84

Students' mean score in relationship to their teacher's instructional style was analyzed to determine their degree of motivation to learn science per instructional style (Table 5.7). Students' mean score for the instructional style one was 84, indicating that students taught by the Pre-Inquiry instructional style are *moderately* motivated to learn science. Students' mean score for instructional style two was100; therefore, students taught by the Developing Inquiry instructional style are *highly* motivated to learn science. The mean score for instructional style three was 99, specifying that students taught by the Proficient Inquiry instructional style are also *highly* motivated to learn science. As the amount of inquiry based learning in the classroom increased, students' mean scores on the motivation survey also increased.

Table 5.7

Means and Standard Deviations from the Science Motivation Questionnaire per Instructional Style

Instructional Style	Mean	Standard Deviation
Pre-Inquiry	84.15	13.09
Developing Inquiry	99.85	12.23
Proficient Inquiry	99.25	18.95

Results from the descriptive statistics indicated the mean scores on each subscale, with the exception of the anxiety about science assessment scale, were greater for the Proficient Inquiry and the Developing Inquiry instructional styles than the scores for the Pre-Inquiry instructional style (Table 5.8). The anxiety about science assessment subscale was reversed scored; therefore, higher scores indicated less test anxiety. Students possessed the least test anxiety for the Proficient Inquiry instructional style and the most test anxiety for the Developing Inquiry instructional style. The mean scores on each scale increased, with the exception of the anxiety about science assessment scale, as the amount of inquiry based instruction increased.

Table 5.8

Means and Standard Deviations from the Science Motivation Questionnaire for Each Subscale per Instructional Style (Calculated per Number of Questions per Subscale)

Subscale	Instructional Style	Mean	Standard Deviation
Intrinsically motivated science learning	1	2.51	0.92
	2	3.46	0.54
	3	3.24	0.76
Extrinsically motivated science learning	1	3.0	0.54
	2	5.62	1.01
	3	3.2	0.93
Personal relevance of learning	1	4.2	0.76
	2	4.77	0.57
	3	4.4	0.88
Self- determination (responsibility) for learning science	1	3.74	0.57
	2	3.94	0.56
	3	4.25	0.54
Self –efficacy (confidence) in learning science	1	2.77	0.50
	2	3.6	0.38
	3	3.63	0.73
	1	3.2	0.50

Anxiety about science assessment	2	3.18	0.10
	3	3.43	0.86

A one-way ANOVA was computed comparing the level of students' motivation to the teachers' instructional style (Table 5.9). The instrument was analyzed in the aggregate for all six subscales and then disaggregated for the individual subscales. The aggregated results indicated no significant effect F (2,25 = 2.95, p >.05 of instructional style on alternative education students' motivation to learn science. However, once the data were disaggregated, statistically significant results were found for the intrinsically motivated subscale F (2,25 = 4.87, p <. 05 and the self-efficacy subscale F (2,25 = 6.64, p <.05. As the amount of inquiry based instruction increased in the classroom, students became more self-motivated to learn science, and their confidence in their ability to learn science improved. The results indicated no significant effects of instructional style on students' motivation to learn science for the other four subscales.

Table 5.9

Analysis of Variance for the Science Motivation Questionnaire

Subscale	df	F	p
Intrinsically motivated science learning	2	4.87	.016*
Extrinsically motivated science learning	2	.39	.68
Personal relevance of learning	2	1.61	.219

Self-determination (responsibility) for learning science	2	1.60	.223
Self-efficacy (confidence) in learning science	2	6.64	.005*
Anxiety about science assessment	2	.213	.809
Total	2	2.95	.071

*p <.05

To determine which groups differed from one another for the intrinsically motivated and self-efficacy scales, a Tukey post-hoc test was conducted and a Multiple Comparisons table was created (Table 5.10). The results of the subscale intrinsically motivated indicated a significant difference between the Pre-Inquiry and Developing Inquiry instructional style (p = .022) and between the Pre-Inquiry and the Proficient Inquiry instructional styles (p = .032). However, there was no significant difference between the Developing Inquiry and the Proficient Inquiry instructional styles (p = .992). The results of the subscale self-efficacy (confidence) in learning science indicated a significant difference between the Pre-Inquiry and the Developing Inquiry instructional styles (p = .007), as well as between the Pre-Inquiry and the Proficient Inquiry instructional styles (p = .012). However, there was no significant difference between the Developing Inquiry and the Proficient Inquiry instructional styles (p-value .994).

Table 5.10

Multiple Comparisons for the Science Motivation Questionnaire

Dependent Variable	(I) Style	(J) Style	Sig.
Intrinsic	1	2	.022*
		3	.032*
	2	1	.022
		3	.992
	3	1	.032
		2	.992
Extrinsic	1	2	.658
		3	.903
	2	1	.658
		3	.908
	3	1	.903
		2	.908
Personal	1	2	.224
		3	.851
	2	1	.224
		3	.492
	3	1	.851
		2	.492
Determination	1	2	.739
		3	.207
	2	1	.739
		3	.442
	3	1	.207
		2	.442
Efficacy	1	2	.007*
		3	.012*
	2	1	.007
		3	.994
	3	1	.012
		2	.994
Anxiety	1	2	.999
		3	.870
	2	1	.999
		3	.810
	3	1	.870
		2	.810
Total	1	2	.075
		3	.134

2	1	.075
	3	.995
3	1	.134
	2	.995

*p < .05

Overall, students were more motivated to learn science as the amount of inquiry based instruction in the classroom increased from Pre-Inquiry to the Developing Inquiry levels. Additionally, students were more motivated to learn science in five of the six subscales as the amount of inquiry based instruction in the classroom increased from Pre-Inquiry to the Developing Inquiry levels. The results of the subscales intrinsically motivated and self-efficacy (confidence) in learning science indicated significant difference between the Pre-Inquiry and Developing Inquiry instructional styles.

Research question 3: How are students' attitudes to learn science influenced by the teachers' pedagogy?

Scientific Attitude Inventory

Evidence of students' attitudes to learn science was discovered using the SAI II. The SAI II consists of 12 position statements. Of the 12 position statements, 6 positions are positive and 6 positions are negative.   Scores on the SAI II may be calculated for each of the 12 position statements, the positive items, the negative items, and the entire SAI II. The minimum score on the entire SAI II is 30 and the maximum score is 150. Students whose score is less than 75 on the SAI II possess a low attitude toward science and students who score greater than 75 on the SAI II possess a high attitude toward science.

Students' mean scores and standard deviations were calculated for each question (Table 5.11). Students earned the highest mean scores on questions 5, 1, 6, and 18. Students *mildly agreed* to the statement "Scientific ideas may be changed over time" (μ = 4.31). Students *mildly agreed* to question one, "Good scientists are willing to change their ideas" (μ = 4.23). They also *mildly agreed* to questions 6 and 18 (μ = 4.19), "Scientists are always interested in better explanation of things" and "Scientists must report exactly what they observe."

Students earned the lowest mean scores on questions 20, 19, 25, and 26. Students *disagreed mildly* that they would like to be a scientist (μ = 2.23). Additionally, students *disagreed mildly* that scientist have to study too much, a major purpose of science is to help people live better, and they would like to work with other scientist to solve scientific problems (μ - 2.54).

Table 5.11

Means and Standard Deviations from the Scientific Attitude Inventory (5 = Agree Strongly to 1 = Disagree Strongly)

Survey Item	Mean	Standard Deviation
1. Good scientists are willing to change their ideas.	4.23	.86
2. I would enjoy studying science.	3.65	1.29
3. I may not make great discoveries, but working in science would be fun.	3.69	1.12
4. Scientific work is useful only to scientists.	3.46	1.27
5. Scientific ideas may be changed over time.	4.31	.79

6. Scientists are always interested in better explanation of things.	4.19	.75
7. Most people are unable to understand science.	3.0	.94
8. Working in a science laboratory would be fun.	3.81	1.27
9. Some questions cannot be answered by science.	3.77	.99
10. When scientists have a good explanation, they do not try to make it better.	3.58	1.14
11. Scientists should not criticize each other’s work.	3.08	1.32
12. Most people can understand science.	3.23	.95
13. Every citizen should understand science.	3.15	1.08
14. Scientific questions are answered by observing things.	3.92	.94
15. Anything we need to know can be found out through science.	3.30	1.09
16. A major purpose of science is to produce new drugs and save lives.	2.73	1.12
17. If one scientist says an idea is true, all other scientists will believe it.	4.12	1.03
18. Scientists must report exactly what they observe.	4.19	.90
19. Scientists have to study too much.	2.54	1.03
20. I would like to be a scientist.	2.23	1.14
21. The search for scientific knowledge would be boring.	3.01	.98
22. Only highly trained scientists can understand science.	3.62	1.27
23. People must understand science because it affects their	3.42	1.17

lives.		
24. Electronics are examples of the really valuable products of science.	2.58	.94
25. A major purpose of science is to help people live better.	2.54	.95
26. I would like to work with other scientists to solve scientific problems.	2.54	1.36
27. Scientists do not have enough time for their families or for fun.	3.58	.99
28. Science tries to explain how things happen.	3.88	.95
29. Scientific work would be too hard for me.	2.92	1.06
30. I do not want to be a scientist.	2.77	1.45

Students earned a mean score of 101 on the SAI II; meaning, generally speaking students possess a high attitude toward science. The mean for the positive items was 54.23 and the mean for the negative items was 46.82

The mean for the entire SAI II for instructional style 1, Pre-Inquiry, was 94.2; instructional style 2, Developing Inquiry μ = 103.54; and instructional style 3, Proficient Inquiry μ= 100.6. The mean indicates there is an increase in attitudes toward science as the amount of inquiry used by the teacher increases from Pre-Inquiry to other levels of inquiry (Table 5.12). The mean for the positive subscale for the Developing Proficiency instructional style (μ = 55.62) and the Proficient Inquiry instructional style (μ = 54.78) were greater than the mean for the Pre-Inquiry instructional style (μ = 48.5). Similarly, the mean for the negative subscale for instructional styles Developing Inquiry (μ = 47.92) and Proficient Inquiry (μ = 45.89) were greater than the mean for Pre-Inquiry instructional style (μ = 45.76). These data indicate there is an increase to at least the Developing Inquiry level in both the positive and negative subscales in students' attitudes toward science as the amount of inquiry used by the teacher increases.

Table 5.12

Means and Standard Deviations from the Scientific Attitude Inventory for the Positive/Negative Subscale per Instructional Style

Subscale	Instructional Style	Mean	Standard Deviation
Positive	1	48.50	13.78
	2	55.52	6.50
	3	54.78	9.46
Negative	1	45.75	6.85
	2	47.92	7.50
	3	45.89	4.94
Total	1	94.2	20.16
	2	103.54	8.73
	3	100.67	12.41

A one-way ANOVA was computed comparing students' attitudes toward science to teachers' instructional style. The entire instrument was analyzed and then the data were disaggregated into individual subscales to further determine if the relationship between instructional style and alternative education students' attitudes toward science differed between the three instructional styles. No significant difference was found between instructional style for the entire scale F (2, 23) = .91, p>.05 (Table 5.13). No significant difference was also found between instructional styles for each of the individual subscales. The students taught by the three different instructional styles did not differ significantly regarding attitudes toward science.

Table 5.13

Analysis of Variance for the Scientific Attitude Inventory (p = .05)

Subscale	Df	F	p
Positive	2	1.02	.376
Negative	2	.32	.73
Laws	2	.54	.59
Explanations	2	.80	.435
Operate	2	2.87	.077
Science	2	.13	.879
Public	2	.42	.664
Scientist	2	1.70	.204
Total	2	.911	.416

*p < .05.

Overall, students' attitudes toward science improved as the amount of inquiry based instruction in the classroom increased from Pre-Inquiry to the Developing Inquiry levels. Additionally, students' attitudes toward science improved on both subscales as the amount of inquiry based instruction in the classroom increased from Pre-Inquiry to the Developing Inquiry levels. However, no significant difference was found between instructional style for the entire scale or the subscales.

Summary

Analysis of the CLES indicated that students, regardless of the instructional style they were taught by, preferred a more constructivist classroom environment than was actually present for all scales with the exception of the science uncertainty scale. Students preferred a more student centered environment which allowed them to work cooperatively. They wanted to discuss their ideas on scientific topics, share their ideas with one another, and reflect upon their ideas. Students wanted to participate in more hands-on investigations which answered their questions, and they wanted the learning to be more relevant to their daily lives. A significant difference in students' attitudes about their actual classroom environment was found between the Pre-Inquiry instructional style and the Developing Inquiry instructional style indicating a significant difference in the level of inquiry based instruction between the two instructional styles.

Students' mean scores on the SMQ increased as the teacher's pedagogical style became more inquiry based, indicating that students' motivation to learn science is influenced by their teacher's pedagogical style. Significant results were obtained from the effect of teacher's pedagogy on the intrinsically motivated scale and the self-efficacy scale. As the teachers' pedagogy became more inquiry based, the students became more self-motivated to learn science, and they became more confident that they could achieve well in science. Although no significant effect was found between students' attitudes toward science and teachers' pedagogy, students' mean scores on the SAI II increased as the teacher's pedagogical style became more inquiry based. This indicated that students' attitudes toward science are influenced by teacher's pedagogical style.

CHAPTER 6

CONCLUSIONS, DISCUSSIONS, AND IMPLICATIONS OF AT-RISK SCIENCE STUDENTS ATTENDING ALTERNATIVE EDUCATION PROGRAMS

Summary of the Study

The researcher conducted a mixed methods study to give voice to the teachers and students who participated in the investigation and to better understand the context of alternative education from their perspectives. “Students are at a good vantage point to make judgments about classrooms because they have encountered many different learning environments and have enough time in class to form accurate impressions” (Fraser, 1998, p. 8). Consequently, it was necessary to allow the alternative education students to voice their opinions on the classroom learning environments to obtain an accurate depiction of the classroom from their perspectives.

At the time the research was conducted, the researcher was employed at an alternative education high school and wanted to investigate how students’ attitudes toward science and motivation to learn science are related to their teachers’ pedagogy. The purpose of this study was to understand the instructional style of four alternative education high school biology teachers and how their instructional style affected the motivation and attitudes of at-risk students toward science. Insights obtained from the results of this study may assist educators to better understand alternative education students and their instructional needs.

The qualitative data consisted of information obtained from interviews, focus groups, and classroom observations. The teachers participated in two interviews. The first interview was utilized to ascertain the teachers' degree of inquiry based instruction. The second interview was designed to further discuss themes which emerged from the qualitative data. Three classroom observations were conducted of each teacher to determine their level of inquiry based instruction. Focus groups were conducted of each teacher's students to further validate the teacher's instructional style from the students' perspective. The quantitative data consisted of information obtained from teacher and student questionnaires. Teachers completed Bandura's Instrument of Teacher Self - Efficacy Scale to determine their degree of self-efficacy and the Science Teachers Efficacy Belief Instrument Form A to measure efficacy of teaching science. Students completed the Constructivist Learning Environment Survey to ascertain their perception of the degree of constructivism practiced in the classroom, the Science Motivation Questionnaire to measure how motivated they are to learn science, and the Scientific Attitudes Inventory to determine their attitudes toward science.

The research questions answered by the investigation were:

1. How do teachers' beliefs about student learning relate to their pedagogy?
2. How is students' motivation to learn science influenced by the teacher's pedagogy?
3. How are students' attitudes to learn science influenced by the teacher's pedagogy?

Discussion

The theoretical framework for this study was based on Bandura’s Social Cognitive Theory and the concept of self-efficacy. Bandura’s Social Cognitive Theory states that human achievement and functioning depend on interactions among one’s behaviors, personal factors (e.g., cognitions, emotions), and environmental conditions (Bandura, 1986, 1997). Bandura (1997) defined self-efficacy as “beliefs in one’s capabilities to organize and execute the course of action required to produce given attainments” (p.3).

Several studies have found that at-risk students tend to have low achievement motivation, low efficacy beliefs, low expectations for success, and express few intrinsic desires to succeed by earning good grades (Huang &Waxman, 1996; Nunn & Parish, 1992; Strahan, 1988.). Alternative education high schools were created to allow students considered at-risk to successfully graduate from high school. Typically, high-risk youth who attend these types of programs have been exposed to negative social and environmental risk factors throughout their lives stemming from problems associated with poverty, family adversity, inadequate parental monitoring, and/or physical and emotional trauma (Guerin & Denti, 1999; Mclntyre, 1993; Waldie & Spreen, 1993). Teachers employed at alternative education high schools must overcome the negative factors associated with their students to instruct them. In order to motivate students to learn science and improve their attitudes toward science, alternative education teachers must incorporate inquiry based instruction, create caring relationships with their students, and relate the learning to students’ daily lives.

Findings

The observations in the four teachers urban and suburban classrooms illustrated many forms of pedagogy including direct instruction, cooperative learning, individual instruction, lecture/discussion, and inquiry. The EQUIP identified Anthony as a Pre-Inquiry teacher, Nancy and Lisa as Developing Inquiry teachers, and Robert as a Proficient Inquiry teacher. Nancy, Lisa, and Robert incorporated more reform-based instructional practices (such as cooperative learning and inquiry based instruction) than Anthony. However, Anthony was found efficacious according to the TSES and STEBBI-A while Nancy, Lisa, and Robert were found inefficacious.

Anthony’s teacher centered, Pre-Inquiry classroom illustrated Haberman’s pedagogy of poverty. According to Haberman (2010), teaching acts that constitute the core function of urban teaching which were present in Anthony’s classroom included giving information, asking questions, giving directions, making assignments, and reviewing assignments. When students entered Anthony’s classroom, the textbook assignment was pre-written on the board. Anthony spent the first few minutes of class informing students of the day’s book work assignment and then students completed the assignment independently. The last few minutes of class were spent reviewing the textbook assignment. During the review of the assignment, Anthony talked to the students and asked questions, but the majority of the students did not respond. During the focus group Anthony’s student stated, “All we do is video and book work.” Another student explained in further detail, “It’s the same questions, he tells you to define the key terms, key ideas, and to answer the five section review questions.”

Guskey & Passaro (1994) define teacher self-efficacy as a teacher's perceived capability to impart knowledge and to influence student behavior, even that of unmotivated or challenging students. Although Nancy, Lisa, and Robert were not found efficacious according to the TSES and STEBI, results from the SMQ indicated their instructional style positively affected students' motivation. Educational research consistently supports the value of scientific inquiry as a motivational tool (Canton, Brewer, & Brown, 2000; Coleman, 2001), and as teacher's instructional style became more inquiry based from Pre-Inquiry to at least the Proficient Inquiry level, students' motivation to learn science increased. Results from the descriptive statistics indicated the mean scores on each subscale of the SMQ, with the exception of the anxiety about assessment subscale, were greater for the Proficient inquiry and the Developing Inquiry instructional styles. Results indicated statistically significant effects of instructional style on students' motivation to learn science for the intrinsically motivated scale and the self-efficacy scale. Students became more self-motivated to learn and their confidence to learn science increased as the level of inquiry in the classroom increased. Nancy, Lisa, and Robert were able to motivate their alternative education students to learn science.

Constructivism can be stated to be a view of learning that considers the learner as a responsible active agent in his/her knowledge acquisition process (Abbott & Ryan, 1999). When teachers adopt constructivist student-centered teaching practices, students become more responsible for their own learning. On the SMQ, students indicated that they "rarely to sometimes" prepare well for science tests and labs and it is "rarely" their fault, if they do not understand the science. In these instances, students held the teacher accountable if they did not understand the science concepts and almost completely absolved themselves of responsibility for their own learning as evidenced by Haberman's pedagogy of poverty. "The students' stake in maintaining the pedagogy of poverty is of the strongest kind: It absolves them of responsibility for learning and puts the burden on the teacher, who must be accountable for making them learn" (Haberman, 1991, p. 292). Additionally, none of the teachers were identified on the EQUIP as Exemplary Inquiry teachers, meaning they can utilize more inquiry teaching practices to encourage students to become more responsible for their learning.

In a comparison of students taught by two different instructional methods, high pragmatic/high inquiry methods and low pragmatic/low inquiry methods, Cavallo and Laubach (2001) found that students who were enrolled in high inquiry classrooms developed more positive attitudes towards science than those who were enrolled in low inquiry classrooms. Results from the SAI-II indicated students' attitudes toward science were affected by teacher's instructional style. Despite the fact that statistically significant data were not found between instructional styles, students' mean scores for the Developing Inquiry and Proficient Inquiry instructional styles were greater than the mean score for the Pre-Inquiry instructional style.

Swackhamer, Koellner, Basile, and Kimbrough (2009) defined personal teacher efficacy as a teacher's belief in his or her skills and abilities to positively impact student achievement, while general (outcome) teaching efficacy has been defined as a teacher's belief that the educational system can work for all students, regardless of outside influences such as socio-economic status and parental influence. All four teachers' STOE scores were lower than their PSTE scores as indicated by the STEBI. During the second interview, teachers stated that students are unable to learn if their basic needs are not met, have low parental involvement, have high truancy rates, are involved in drugs or alcohol, or are grieving the loss of friends due to violence. Teachers believed they possessed the ability to effectively teach science. Nevertheless, they felt as though their best teaching practices could not overcome their students' negative situations. They contributed their students' inability to learn science exclusively to students' negative situations and not their own teaching ability or chosen instructional strategies.

The classroom environment is particularly influential in terms of student academic outcomes (Martin & Dowson, 2009) and has been defined as the ''general class atmosphere including attitudes towards learning, norms of social interactions, acceptance of ideas and mistakes, and learning structures set by the teacher'' (Urdan & Schoenfelder, 2006, p. 340). During the second interview, all four teachers indicated that they believed their instructional strategies were effective and that the strategies motivated their students to learn science. Research comparing teacher and student perceptions of the same classroom has generally demonstrated that teachers' perceptions are more positive than those of the students (Dorman, 2008; Fraser, 1982; Raviv, Raviv, & Reisel, 1990; Sinclair & Fraser, 2002). All four teachers perceived the classroom learning environment as positive enough to increase students' motivation to learn science and improve students' attitudes toward science. However, the students preferred a more constructivist classroom than was actually present as indicated by the CLES and the focus group interviews. Students wanted an opportunity to explain and justify their ideas to classmates, listen to the ideas of other students, and reflect on their own ideas.

Evidence from the CLES and the student focus groups indicated students preferred an environment that allowed them to conduct more investigations. All four teachers indicated a lack of laboratory materials and equipment and three teachers stated that not being assigned to a proper science laboratory classroom were reasons students could not participate in additional inquiry based investigations; however, students did not recognize the lack of materials and space as impediments to participating in inquiry based investigations.

Relevancy of the science content emerged from the qualitative data as a necessary factor to motivate students to learn science and to improve their attitudes toward science. Making science relevant to students' personal lives makes science worth studying for reluctant learners and those students who are not interested in science (Daniels & Arapostathis, 2005; Sagor, 2002; Strong, Silver, & Robinson, 1995). All four teachers agreed that relevancy is required for the alternative education population and stressed the relevancy of topics on a regular basis. According to the CLES, students preferred an environment that related the learning experiences to their daily lives, and during the focus groups, students admitted that the real world application of what they learned in biology motivated them to learn science. One of Nancy's students stated that 98% of what she learned in biology is related to her daily life.

Of the eight principles of highly effective alternative education programs mentioned by Smith and Thomas (2001) and NGA Center for Best Practices (2001), two were evidenced in the research study: physical and psychological safety (e.g., safe facilities, safe ways to handle conflicts between youth, etc.) and supportive relationships (warmth, closeness, etc., with adults and peers). On the "create a positive school climate" TSES subscale four alternative education teachers indicated that they have some influence to create a positive school climate. Anthony, who indicated quite a bit of influence, believed he possessed more influence to create a positive school climate than Nancy, Lisa, and Robert.

Although caring relationships was not a focus of the interview questions, caring relationships emerged as a theme once the data were analyzed. Literature that discusses teacher care affirms that students experience positive school outcomes, such as improved attendance, attitude, self-esteem, effort, and identification with school, if they believe their teachers care for them and their wellbeing (Steele, 1992; Noblit, Rodgers, & McCadden, 1995; Noddings, 1995). All four teachers referenced caring relationships as a reason for students' motivation to learn science. During each focus group, students also addressed caring relationships from their perspective. One student stated, "We all have our own personal relationship with Nancy; it makes you want to come to school and learn. She is a good teacher." Even though Anthony was identified as a Pre-Inquiry teacher by the EQUIP and evidence from the focus group and CLES indicated his students wanted to participate in more inquiry based activities, students were still motivated to complete bookwork assignments due to the caring relationships between him and his students.

Implications

The findings add to the wealth of literature on inquiry based learning, motivation of science students, and the attitudes of science students but in an often not studied population. Several studies have found that at-risk students tend to have low achievement motivation, low efficacy beliefs, low expectations for success, and express few intrinsic desires to succeed by earning good grades (Huang &Waxman, 1996; Nunn & Parish, 1992; Strahan, 1988). However, there are not many studies which indicate how to motivate and improve the science attitudes of the at-risk population. The findings have important implications for methods of teaching and motivating alternative education students and improving their attitudes toward science.

The results of the study provide implications for teachers, administrators, and curriculum developers. Principals and curriculum developers can use the results of the research to create professional development for teachers focusing on ethics of care and academic relevancy to motivate students to learn science and to improve students' attitudes toward science. Professional development pertaining to ethics of care and academic relevancy are especially important for alternative education teachers because at-risk students are more difficult to motivate than students not considered at-risk. It is imperative for alternative education teachers to develop caring relationships with their students and for them to focus on relevancy of learning to motivate students to learn science and improve their attitudes toward science.

The results of the study provide implications for the need of inquiry based professional development specifically designed for alternative education science teachers. Unlike comprehensive high school science teachers, alternative education science teachers often do not have the necessary materials and equipment for their students to participate in hands-on investigations. Consequently, it is necessary for inquiry based professional development designed for alternative education teachers to focus on investigations which could be completed with readily available, daily household materials. The topics of investigation would need to be standards based, engaging, and relevant to students' daily lives. The activities would also need to be completed during a 45 minute class period.

Many alternative education science teachers are the only science teacher employed by their school. As a result, they do not have the opportunity to collaborate with other science teachers regarding planning, assessment, or curriculum. Principals of alternative education schools in neighboring school districts should create professional learning communities to allow their science teachers to share ideas, strategies, and curricula.

The results from the literature can also be used by alternative education high school principals to insist that teachers develop caring teacher-student relationships, integrate relevant content, and incorporate inquiry based learning to motivate students to learn science and improve the attitudes of students toward science. It is also necessary for alternative education principals to provide funds to allow teachers to purchase necessary materials and equipment, enabling students to participate in inquiry based activities.

Recommendations

The sample of participants was small and specific to the alternative student population. The study was conducted in only four school districts within one state. It is recommended that this study be replicated with a larger participant pool and in both alternative education science classrooms and in comprehensive high school science classrooms. The replicated study should also include rural, suburban, and urban classroom settings.

There was a two year gap between teachers' first and second interview. During the two year time period, teachers' beliefs may have changed due to participating in professional development or graduate level classes. Additionally, two of the teachers were no longer employed by alternative education high schools. Therefore, they responded to the second interview questions based on previous experience teaching alternative education students. It is recommended that this study be replicated without a lengthy gap between teachers' first and second interviews.

According to Smith and Thomas (2001) and NGA Center for Best Practices (2001), highly effective alternative education programs are generally known for their adherence to youth development principles, such as (1) physical and psychological safety (e.g., safe facilities, safe ways to handle conflicts between youth, etc.); (2) appropriate structure (limit setting, clear rules, predictable structure to how program functions, etc.); (3) supportive relationships (warmth, closeness, etc. with adults and peers); (4) opportunities to belong (meaningful inclusion); (5) positive social norms (expectations of behaviors, etc.); (6) support for efficacy and mattering (empowering youth, challenging environment, chances for leadership, etc.); (7) opportunities for skill building (e.g., learning about social, communication skills, etc., as well as media literacy, good habits of the mind, etc.); and (8) integration of family, school, and especially community efforts (National Research Council and Institute of Medicine, 2001). However, appropriate structure, opportunities for students to belong, positive social norms, support for efficacy and mattering, opportunities for skill building, integration of family, school, and especially community efforts were not the focus of this study. It is recommended that a researcher investigating the effectiveness of alternative education programs focus on the qualities of effective alternative education programs identified by Smith and Thomas (2001) and NGA Center for Best Practices (2001).

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APPENDIX A: ALTERNATIVE EDUCATION TEACHERS' EQUIP SCORES

TABLE A.1 ALTERNATIVE EDUCATION TEACHERS' EQUIP SCORES

	Observations			
Teacher	One	Two	Three	Overall Equip Score
Anthony	1	1	1	1
Nancy	2	2.2	1.9	2
Lisa	1.5	1.8	1.6	2
Robert	2.5	2.8	2.5	3

APPENDIX B: CUT SCORES FOR BANDURA’S INSTRUMENT TEACHER SELF-EFFICACY SCALE

TABLE B.1 CUT SCORES FOR BANDURA’S INSTRUMENT TEACHER SELF-EFFICACY SCALE

Percentile	Cut Score
10	84
20	84
25	86
30	88
40	92
50	92
60	92
70	105
75	111.5

APPENDIX C: CUT SCORES FOR THE SCIENCE TEACHER SELF-EFFICACY BELIEF INSTRUMENT

TABLE C.1 CUT SCORES FOR THE SCIENCE TEACHER SELF-EFFICACY BELIEF INSTRUMENT

Percentile	Cut Score
10	85
20	85
25	85
30	86
40	87
50	87
60	87
70	90
75	92.25

APPENDIX D: CUT SCORES FOR THE SCIENTIFIC ATITUDES INVENTORY

TABLE D.1 CUT SCORES FOR THE SCIENTIFIC ATITUDES INVENTORY

Percentile	Cut Score
10	85.7
20	92.4
25	95.25
30	97
40	100
50	102.5
60	105
70	107.8
75	109

APPENDIX E: CUT SCORES FOR THE SCIENTIFIC ATTITUDE INVENTORY POSITIVE/NEGATIVE SUBSCALES

TABLE E.1 CUT SCORES FOR THE SCIENTIFIC ATTITUDE INVENTORY POSITIVE/NEGATIVE SUBSCALES

Percentile	Cut Score
10	41.4
20	50
25	50.8
30	52.1
40	53
50	54.5
60	56.2
70	58
75	58

APPENDIX F: MEANS FROM BANDURA'S INSTRUMENT TEACHER SELF-EFFICACY PER SUBSCALE FOR EACH TEACHER

TABLE F.1 MEANS FROM BANDURA'S INSTRUMENT TEACHER SELF-EFFICACY PER SUBSCALE FOR EACH TEACHER

	Subscale Mean							Total Mean
Teacher	Decision Making	Influence School Resources	Instructional	Disciplinary	Enlist Parental Involvement	Enlist Community Involvement	Create a positive School Climate	
Anthony	10	4	34	14	11	12	33	118
Nancy	6	3	25	12	7	12	27	92
Lisa	8	2	24	24	8	9	24	84
Robert	8	4	24	11	9	12	24	92

APPENDIX G: MEANS FROM BANDURA’S INSTRUMENT TEACHER SELF-EFFICACY PER SUBSCALE FOR EACH TEACHER (PER NUMBER OF QUESTIONS EACH SUBSCALE)

TABLE G.1 MEANS FROM BANDURA’S INSTRUMENT TEACHER SELF-EFFICACY PER SUBSCALE FOR EACH TEACHER (PER NUMBER OF QUESTIONS EACH SUBSCALE)

				Subscale Mean			
Teacher	Decision Making	Influence School Resources	Instructional	Disciplinary	Enlist Parental Involvement	Enlist Community Involvement	Create a positive School Climate
Anthony	5	4	3.78	4.67	3.67	3	4.13
Nancy	3	3	2.78	4	2.33	3	3.38
Lisa	4	2	2.67	3	2.67	2.25	3
Robert	4	4	2.67	3.67	3	3	3

APPENDIX H: MEANS SCIENCE TEACHER EFFICACY BELIEF INSTRUMENT

TABLE H.1 MEANS SCIENCE TEACHER EFFICACY BELIEF INSTRUMENT

Teacher	PSTE	STOE	Mean Difference PSTE and STOE	Entire (115 maximum score)
Anthony	59	35	24	94
Nancy	47	38	9	85
Lisa	45	42	3	87
Robert	51	36	15	87

APPENDIX I: LETTER TO ALTERNATIVE EDUCATION HIGH SCHOOL PRINCIPALS

August 22, 2012

RE: Permission to Conduct Research Study

Dear Principal:

I am writing to request permission to conduct a research study at your alternative education high school. Your biology teacher has consented to participate in the research. I am currently enrolled in the Ph.D. in Secondary Education Program at the University of South Carolina in Columbia, SC, and I am in the process of writing my dissertation. The study is entitled *The Effect of Teachers' Instructional Style on the Motivation and Attitudes of At-Risk Science Students Attending Alternative Education Programs.*

I hope that the school administration will allow me to conduct three classroom observations and allow students to voluntarily participate in a focus group and complete three surveys (copies attached). If approval is granted, student participants will complete the survey and focus group in the science classroom during their science period The survey process should take no longer than 30 minutes and the focus group should take no longer than 45 minutes. Students will remain anonymous by not writing their names on the surveys and students will only use their first names during the focus group. Should this study be published, the names of the teacher, school, school district, or city will not be utilized. No costs will be incurred by either your school or the individual participants.

Your approval to conduct this study will be greatly appreciated. I will follow up with a telephone call next week and would be happy to answer any questions or concerns that you may have at that time.

If you agree, kindly scan the form and send it to my email address.

Sincerely,

Michiko Berry McClary
Ph.D. Candidate

Approved by:

______________________________________ ________________________________ __________

Print your name and title here
Signature Date

APPENDIX J: ALTERNATIVE EUCATION SCIENCE TEACHER INTERVIEW

1. How old are you?
    a. Under 25
    b. 25–29
    c. 30–39
    d. 40–49
    e. 50–59
    f. 60 or older

2. Are you female or male?

3. By the end of this school year, how many years will you have been teaching altogether? Do not include teaching as a substitute or student teacher.

4. What is the highest level of formal education you have completed?
    a. Completed an academic Associate’s or Bachelor’s degree
    b. Completed an academic Master’s degree, postgraduate certificate program (e.g., teaching) or first professional degree (e.g., law, medicine, dentistry)
    c. Completed a doctorate (Ph.D. or Ed.D)

5. How many years of preservice teacher training did you have (e.g., time spent in a teacher education program such as student teaching or a mentorship)? Please round to the nearest whole number
    a. 0 years
    b. 1 year
    c. 2 years
    d. 3 years
    e. 4 years
    f. 5 years
    g. More than 5 years

6. During your college or university education what was your main area(s) of study?
    a. Biology
    b. Chemistry
    c. Physics
    d. Earth Science
    e. Science Education
    f. Other ___________________________________

7. What requirements did you have to satisfy in order to become a science teacher?
    a. Complete a bachelor’s degree
    b. Complete a probationary period
    c. Complete a minimum number of education courses
    d. Complete a minimum number of science courses
    e. Pass a licensing examination
8. What type of license or certificate do you hold?
    a. Regular or standard state certificate or advanced professional certificate
    b. Probationary certificate (the initial certificate issued after satisfying all requirements except the completion of a probationary period)
    c. Provisional or other type given to persons who are still participating in what the state calls an “alternative certification program
    d. Temporary certificate (requires some additional college coursework and /or student teaching before regular certification can be obtained)
    e. Emergency certificate or waiver (issued to persons with insufficient teacher preparation who must complete a regular certification program in order to continue teaching)

9. In one typical calendar week from Monday to Sunday, what is the total number of single periods for which you are formally scheduled? Count a double period as two periods.

10. Of these formally scheduled periods, for how many are you assigned to do each of the following?
    Write in the number of periods
    a. Teach general science
    b. Teach physical science
    c. Teach physics
    d. Teach chemistry
    e. Teach life science/biology
    f. Teach Earth science
    g. Teach mathematics
    h. Teach other subjects
    i. Perform other duties

11. Outside the formal school day, approximately how many hours per week do you normally spend on each of these activities? Please round to the nearest whole number. *Write in the number of hours per week*
    a. Grading student tests, exams, or other student work
    b. Planning lessons
    c. Administrative and recordkeeping tasks including staff meetings
    d. Other

How often do you have the following types of interactions with other teachers?

1	Daily or almost daily	2	1-3 times per week
3	2 or 3 times per month	4	Never or almost never

a. Discussions about how to teach a particular concept
b. Working on preparing instructional materials
c. Visits to another teacher's classroom to observe his/her teaching
d. Informal observations of my classroom by another teacher

12. In the past two years, have you participated in professional development in any of the following? Please answer yes or no.
    a. Science Content
    b. Science Pedagogy/Instruction
    c. Science Curriculum
    d. Integrating information technology into science
    e. Improving students' critical thinking or inquiry skills
    f. Science assessment

13. To what extent do you agree or disagree with each of the following statements?

    1 – Agree a lot 2 – Agree 3 – Disagree 4 – Disagree a lot

    a. More than one representation (picture, concrete material, symbols, etc.) should be used in teaching a science topic
    b. Solving science problems often involves hypothesizing, estimating, testing, and modifying findings
    c. Learning science mainly involves memorizing
    d. There are many ways to conduct a scientific investigation
    e. Getting the correct answer is the most important outcome of a student's scientific experiment
    f. Scientific theories are subject to change
    g. Science is taught primarily to give students the skills and knowledge to explain natural phenomena
    h. Modeling natural phenomena is essential to teaching science
    i. Most scientific discoveries have no practical value

In teaching science to the students in the, how often do you usually ask them to do the following?

1- Every or almost every lesson 2 - About half the lessons
3- Some lessons 4- Never

a. Observe natural phenomena and describe what they see
b. Watch me demonstrate an investigation or experimentation
c. Design or plan experiments or investigations
d. Conduct experiments or investigations
e. Work together in small groups on experiments or investigations
f. Read their textbooks or other resource materials
g. Have students memorize facts and principles
h. Give explanations about something they are studying

i. Relate what they are learning in science to their daily lives

14. Do students have computers available to use during their science lessons?

15. Do the computers have access to the Internet?

16. In teaching science, how often do you have students use a computer for the following activities?

1- Every or almost every lesson	2 - About half the lessons
3- Some lessons	4- Never

a. Do scientific procedures or experiments
b. Study natural phenomena during simulations
c. Practice skills and procedures
d. Look up ideas and information
e. Process and analyze data

17. How would you describe your availability of necessary laboratory equipment?
18. What strategies do you use to motivate students to learn science?

APPENDIX K: ALTERNATIVE EDUCATION TEACHERS GOALS INTERVIEW

(FOLLOW-UP INTERVIEW)

1. What does a typical day look like in your classroom? Why do you choose to teach in this way?
2. What are your goals for the students you teach? (follow ups might ask—goals for learning the standards, verses goals for life skills)
3. What do you do when your students do not obtain the goals you set for them?
4. What methods (instructional strategies) do you utilize to ensure your students obtain the goals you set for them? How do you vary your strategies if students do not understand?
5. Are your teaching methods (instructional strategies) effective? What evidence suggests that your teaching methods are effective? What might be some reasons students are not learning, despite your efforts?
6. Do your teaching methods motivate your students to learn science? What evidence suggests that your students are motivated to learn science?
7. Do your teaching methods improve your students' attitude toward science? What evidence suggests that your students' attitudes toward science are improving?

APPENDIX L: ALTERNATIVE EDUCATION SCIENCE STUDENTS FOCUS GROUP INTERVIEW QUESTIONS

Good afternoon, my name is Michiko McClary, and I am the science teacher at Village High School in Pleasanton, CA where I teach physical science and biology. I am also a graduate student in science education earning an advanced degree and I am interested in the relationship between students' attitudes toward learning science and their teachers' instructional methods.

Before we begin, let me suggest some things to make our discussion more productive. Because I'll be recording for an accurate record, it is important that you speak up and that you only speak one at a time. I don't want to miss any of your comments.

We'll only use first names here. No reports will link what you say to your name, school, or district. In this way, I will maintain your confidentiality. In addition, I ask that you also respect the confidentiality of everyone here. Please don't repeat any comments you heard when you leave this room.

During the forty-five minutes we'll be here, I will ask you questions, and I will listen to what you have to say. I will not participate in the discussion. So please, feel free to respond to each other and to speak directly to others in the group. I want to hear from all of you. So I may encourage someone who has been quiet to talk or ask someone who is extremely talkative to wait a few minutes before continuing.

If it is OK with you, I will turn on the recorder and start now.

This focus group is being conducted on _________, at the campus of _________and the start time is _________.

I. Let's begin with introductions.
    A. Please tell me your first name, grade level, and the amount of time you have attended this school.

II. Now that I know a little about you, I'd like you to think back to when you attended comprehensive high school before attending ___________ (name of the alternative school.)
    A. What did you like about your science class?
    B. What did you dislike your about science class?

C. How did that science class differ from your current science class?

III. Now I would like to talk to you about what has happened you have attended an alternative school.

A. Do you enjoy learning about science?
B. What do you like to learn about science?
C. What would you say has been the most productive way for you to learn biology

(for example, lecture, taking notes, discussion, performing experiments in the lab, reading the textbook).

D. What would you say has been the most unproductive way for you to learn biology (for example, lecture, taking notes, discussion, performing experiments in the lab, reading the textbook).

E. What does your teacher do to motivate you to learn science?

F. What experiences have you had that improved your attitude toward learning science?

G. How often do you work in groups?

H. Tell me about the last group activity you participated in.

I. How often do you complete laboratory activities?

J. Tell me about the last laboratory activity you completed.
K. How does your teacher know when you have learned the content after doing a lab or activity?
L. How do you prefer to learn science, what type of activities would you prefer to participate in?
M. Does your teacher use the methods you prefer? How does your teacher do this?
N. Do you feel as though you have a personal relationship with your science teacher?
O. How does the relationship with your science teacher improve your motivation to lean science?