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Investigating the Relationships between Seventh and Eighth Grade Science Teachers' Background, Self-efficacy toward Teaching Science as Inquiry, and Attitudes and Beliefs on Classroom Control

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Investigating the Relationships between Seventh and Eighth Grade Science Teachers' Background, Self-efficacy toward Teaching Science as Inquiry, and Attitudes and Beliefs on Classroom Control

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ABSTRACT

An important component of science reform is the teaching of science as inquiry. Many barriers toward teaching science as inquiry have been documented but the list is incomplete. This study utilized a non-experimental correlational design to examine middle school science teachers' background and the relationships this has with teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs on classroom control. Because science inquiry activities involve greater classroom control skills by the instructor as opposed to teacher-centered instruction, the relationship between teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs on classroom control were important features in framing the research questions for this study.

Packets containing a teacher background survey, the Teaching Science as Inquiry (TSI) instrument and the Attitudes and Beliefs on Classroom Control – Revised (ABCC-R) instrument were mailed to 303 science teachers representing all schools in Montana that offer 7th and 8th grade science. There were 132 completed and returned packets for a response rate of 43.6%. Thirteen teacher background independent variables were used for between group comparisons and regression analyses with the TSI and instruction management (IM) and people management (PM) subscales of the ABCC-R which served as dependent variables. A Pearson product moment correlational analysis was conducted to examine the relationship between TSI scores and the scores of the two subscales of the ABCC-R instrument.

The statistically significant findings resulting from the inferential statistical analyses indicated that teachers with master's degrees, teachers with science majors, teachers with

inquiry professional development experience, and teachers with experience working with a scientist or in a research environment scored significantly higher on the TSI instrument than teachers with bachelor's degrees, teachers without a science major, teachers with no inquiry professional development experience, and teachers who had no research experience, respectively. Teachers with science research experience who had less than five hours of preparation per week were found to be significantly less controlling than teachers without science research experience who had more than five hours of preparation time per week. No statistical significance was found with regards to teachers' self-efficacy towards teaching science as inquiry and their attitudes and beliefs on classroom control. A statistically significant positive correlation between the IM and PM scores was observed.

DEDICATION

This dissertation is dedicated to my mother, Dimple I. Joern, whose love and support has always been immeasurable.

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CHAPTER 1 - INTRODUCTION

The call for a more scientifically literate population has provided the wheels in moving science education reform forward (Bybee & Van Scotter, 2006; Loucks-Horsley & Bybee, 1998; Wenglinsky & Silverstein, 2006; Wheeler, 2006). Bybee (2008) claims, "In today's world, scientific literacy has become essential to full participation of citizens" (p. 566). The ebb and flow of science reform has consistently included the idea of inquiry as a component since the early twentieth century marked by the educational philosophies of John Dewey. At the center of science literacy is the understanding of the nature of science which is connected to the understanding of scientific inquiry (Lederman, 1998; Ross, Skinner & Fillippino, 2005). Throughout the *National Science Education Standards* (NSES), inquiry is the force that drives what science is learned and how science is learned (NRC, 1996; 2000). The NSES identify that "scientific literacy enables people to use scientific principles and processes in making personal decisions and to participate in discussions of scientific issues that affect society" (p. ix). To realize this goal, it will be imperative that many science teachers change their beliefs and practices with regards to their instruction. This includes teachers' view of science, epistemological beliefs, and an adoption of social constructivist teaching approaches (Kang, 2008).

In spite of the rally cries to promote and implement inquiry-based instruction, traditional teacher-lead lectures dominate the science experience for many students. Chiappetta and Koballa (2006) mince no words with regards to their perspective towards the teaching of science in today's classrooms:

> A great deal of science teaching that takes place in middle and senior high schools, as well as at the collegiate level, can be characterized as teaching the

> products of science. This mode of teaching is designed to present a body of information that has been organized by the teacher or the textbook. Unfortunately, this approach often omits the thinking that was used and the paths that were taken to form the knowledge. This approach also minimizes the firsthand and minds-on experiences that should be provided. Teaching science as a body of knowledge results in conveying the abstracted and distillated, polished, and pristine outcomes of the learning process that others have gone through to construct new knowledge. As a consequence, this approach often conveys ideas that have little meaning to students, resulting in the poor memorization of ideas that are learned poorly. Content with little or no process is not recommended for science education. (p. 144)

Teaching by inquiry models the way practicing scientists address scientific questions and promotes students' understanding of the nature of science. The National Science Education Standards state:

> Inquiry teaching requires that students combine processes and scientific knowledge as they use scientific reasoning and critical thinking to develop their understanding of science. Engaging students in activities of and discussions about scientific inquiry should help them to develop an understanding of scientific concepts; an appreciation of 'how we know' what we know in science; understanding of the nature of science; skills necessary to become independent inquirers about the natural world; and the dispositions to use the skills, abilities, and attitudes associated with science. (p. 6)

In inquiry investigations, students view themselves as active participants in their learning and plan and carry out their investigations using a variety of methods (Ash and Kluger-Bell, 2000). Learning science through inquiry allows students to experience growth and challenges that typically go beyond what direct instruction alone will provide.

Effective teaching and learning through inquiry require a multi-faceted approach to pedagogy. Teachers who facilitate inquired-based instruction have to address a variety of concerns which include time and energy, classroom constraints, reading and language levels, student maturity, safety concerns, thinking skill abilities, support from administrators and parents, and science materials management (Baker, Lang & Lawson, 2002). While some may view this as burdensome and overwhelming, research bears witness to the effectiveness of learning through the processes of inquiry.

Support for the contention that students learn science better from inquiry-based laboratory activities is well documented (Anderson, 2002; Blank, 2000; Haury, 1993; Lord & Orkwiszewski, 2006; Shymansky, Kyle & Alport, 1983). Students with disabilities have higher achievement scores with inquiry-oriented science teaching (Scruggs & Mastropieri, 1993) and inquiry allows urban students to find greater congruence between their classroom science experience and their own lives (Barton, 1998).

Students of science teachers who promote inquiry-based laboratory skills are reported to score higher on science concept assessments than those students who engage in cookbook laboratory investigations (Wenglisky & Silverstein, 2006). Meta-analyses of inquiry teaching in science reveal positive gains in student understanding and achievement. In their meta-analysis of inquiry teaching, Shymansky et al. (1983) found substantial effect sizes relating to inquiry-based instruction in the areas of cognitive achievement, process skills and attitude towards science. An effect size of 0.4 standard deviations was reported by Wise and Okey (1983) with regards to cognitive outcomes using inquiry-discovery teaching. While research supports the use of inquiry-based science instruction, the choice to do so ultimately rests with the individual teachers. There are many factors that influence teachers' pedagogy, attitude, motivation, and training, which in turn effect the decisions teachers make about their instruction. One very important component in the complicated equation that defines a teacher is teacher self-efficacy and its relationship to beliefs. Teacher beliefs are critical to the success of science reform (Putnam & Borko, 2000).

Self-efficacy is a construct described by Bandura (2006a) as the beliefs that "affect people's goals and aspirations, how well they motivate themselves, and their perseverance in the face of difficulties and adversity" (p. 4). Teachers' efficacy has been addressed in a general sense (Gibson and Dembo, 1984; Tschannen-Moran & Hoy, 2001) as well as in specific dimensions such as science (Cakiroglu, Cakiroglu, & Boone, 2005; Riggs and Enoch, 1990), special education (Coladarci & Breton, 1997), and classroom control and management (Emmer, 1990; Martin, Yin, & Baldwin, 1998b; Savran & Cakiroglu, 2003). Research supports teacher self-efficacy as an important link across effective classroom management, teaching and learning (Gibson & Dembo, 1984; Roberts & Henson, 2001; Podell & Soodak, 1993; Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998).

Tschannen-Moran and Woolfolk Hoy (2001) state, "Teacher efficacy has proved to be powerfully related to many meaningful educational outcomes such as teachers' persistence, enthusiasm, commitment and instructional behavior, as well as student outcomes such as achievement, motivation, and self-efficacy beliefs" (p. 783). Given the variety of pedagogical components necessary for inquiry-based instruction, teacher beliefs regarding the self-perceived capability of effectively facilitating learning by inquiry is an important construct to examine. While Chiappetta and Koballa (2006) assert that teachers who possess a great deal of energy are more likely to teach science as inquiry, Marshall, Horton, Igo and Switzer (2008) suggest that teachers owning a higher sense of self-efficacy towards teaching science as inquiry might have the motivation to engage their students in learning science through inquiry and persist when encountering challenges whereas lower self-efficacious teachers might be far less inclined to attempt inquiry instruction. Teachers who possess high self-efficacy beliefs tend to invest more of themselves in their instruction, have higher levels of aspiration and set greater goals (Woolfolk Hoy & Davis, 2006). These teachers spend more time planning and organizing their lessons and generally are more enthusiastic in their teaching (Muijs & Reynolds, 2001). Highly efficacious teachers are more likely to experiment with new methods, generally use inquiry-oriented instruction more than teachers with low self-efficacy, and accept the challenges of science teaching methods such as inquiry that are often more difficult to manage (Chacon, 2005; Cousins & Walker, 2000; Czerniak, as cited in Moscovici, 1999).

Regardless of the instructional strategies employed by teachers, classroom management has been and always will be a concern. It has been suggested that educators often see classroom control as more important than the learning that is supposed to happen in the classroom (Edwards, 1997). While there is no agreed upon consensus regarding management as a construct, the research literature suggests that it includes student behavior, social interaction, and the learning by students (Martin, Yin & Baldwin, 1998b). Emmer and Stough (2001) state that the "broad view of classroom management encompasses both establishing and maintaining order, designing effective instruction, dealing with students as a group, responding to the needs of individual students, and effectively handling the discipline and adjustment of individual students" (p. 104). Teachers' strategies toward classroom management and control are influenced by their values, their own past educational experiences, teacher training, supplemental professional development and their self-efficacy (Cakiroglu et al., 2005; Morris-Rothschild & Brassard, 2006; Savran & Cakiroglu, 2003; Yilmaz & Cavas, 2008; Woolfolk & Hoy, 1990).

Inquiry teaching shifts a significant amount of learning to the students as they construct knowledge. In this environment, student-student interactions and movement around the classroom increase sharply when compared to direct instruction. While Glasser (as cited in Wolfgang and Glickman, 1986, p. 193) believes that students are capable of being rationale and responsible with regards to their behavior, it is agreed upon that this cannot be effectively achieved without guidance from a teacher. Students can't be expected to always be able to control their behaviors in a manner that is conducive to maximum learning. Teachers' management and control strategies are critical components in achieving success with inquiry-based instruction and since self-efficacy influences practice, beliefs about management is manifested in the teaching strategies that teachers choose. A connection between self-efficacy toward teaching science as inquiry and classroom control emerges.

As research techniques and measurements improve in the area of teacher self-efficacy, a greater resolution is obtained as we look to identify and understand efficacious traits and their affect upon instruction and learning. Self-efficacy beliefs are domain specific and address an individual's perception to execute particular tasks within explicit domains (Pajares, 1996). Schunk and Meece (2006) provide self-efficacy examples such as "performing operations on different types of radical expressions, safely driving an automobile under different condition and learning technical terms in biology" (p. 75). It cannot be assumed that a teacher with a high self-efficacy in one area, such as content knowledge, assessment, or discipline, will have a similar high self-efficacy in a different area, which is why relationships between domains yields a richer understanding of instructional practices than what individual components of self-efficacy reveal independently. Woven into the fabric of teachers beliefs are the influences of teachers' background experiences. Background impacts efficacies which in turn affects practice.

Middle school teachers represent a unique population of science teachers due in part to the teacher preparation qualifications required to teach science at this level. While some states require at least a college minor in order to teach middle school science, others do not (Boyd, Goldhaber, Lankford, & Wyckoff, 2007). For example, the state of Montana has no subject area requirements for beginning middle school science teachers. Montana teachers with a K-8 elementary endorsement are permitted to teach science at the middle school level alongside teachers with specific science endorsements (Montana Office of Public Instruction, 2005). This variation in teaching qualifications provides a wide array of teacher background experiences to explore in relation to the teaching of science as inquiry.

Middle school science teachers' classroom management and control efficacy and the relationship it has with teachers' efficacy toward the teaching of science as inquiry has not been deeply explored and is worthy of a closer examination. Additional investigation into teachers' background experiences and the effect on self-efficacy aids in illuminating factors associated with teacher beliefs. If the science teaching domain of self-efficacy toward teaching science as inquiry is significantly related to a specific domain of classroom management and background experiences, implications for teacher preparation and professional development emphasis become noteworthy.

Statement of the Problem

Regarding the teaching of science as inquiry,

"We espouse the idea but do not carry out the practice."

(Bybee, 2000, p. 20)

In spite of the vigorous promotion of inquiry in science education, the extent of its practice at the classroom level as intended in the NSES falls short. Reiff (2002) asks, "If inquiry is so great, why isn't everyone doing it?" (p. 2). Data from the Report of the 1993 National Survey of Science and Mathematics Education reveal that throughout K-12 science education, hands-on/laboratory work accounted for only 23% of class time with lecture/discussion and individual seatwork comprising 57% of class time (Weiss, Matti, & Smith, 1994). According to the findings of the National Education Goals Panel (1995), only 41% of eighth grade science students participate in science investigations on a weekly basis. The U.S. Department of Education found that 69% of U.S. 12th graders "never or hardly ever" designed and carried out their own scientific investigations

(O'Sullivan & Weiss, 1999). Clearly, inquiry-based instruction has yet to manifest itself at the level professional science educators would like to see.

Answers to Reiff's (2002) question include: teachers teach the way they've been taught, it's hard to do, it's time consuming, materials are costly, and a lack of professional development (Crawford, 2007; French, 2005; Marlow & Stevens, 1999). Inquiry takes time and teachers feel the need to cover the book (Anderson, 2002). Beginning teachers often have difficulty in planning and implementing inquiry-based science lessons (Adams & Krockover, 1997; Hashweh, 1987). Even though new teachers may have received inquiry-based instruction in teacher preparation courses, they often have trouble transferring their teacher preparation experience into their classroom contexts (Geddis and Roberts, 1998; Prawat, 1992). Teachers often refer to their own lack of science inquiry experiences when they were students as a reason for not including inquiry-based lessons in their instruction (Moscovici, 1999). Lack of science inquiry practice is not limited to the elementary level. Marlow and Stevens (1999) contend that most secondary teachers fail to understand how problem-solving and the construction of science knowledge can be influenced by inquiry. While new teachers may need experience to facilitate inquiry-based instruction (Crawford, 1999), veteran teachers have teaching experience, have had exposure to inquiry-based strategies through professional writings, and have often had opportunities to engage in professional development. *This begs the question, what are the barriers for practicing science teachers?*

Even while teacher beliefs about inquiry are positive, quite often their practice does not support these beliefs (Keys, 2005). Most teachers support hands-on instruction and feel that the value from activity-based instruction is worth the time and effort (Weiss, 1997). Chen, Taylor & Aldridge (1997) found that even though the beliefs toward scientific inquiry of Australian science teachers are generally consistent with today's definition, their students indicate that inquiry-based teaching practices occur infrequently. Roehrig and Luft (2004) sum up the use of inquiry as being challenging, but critical. Solutions towards overcoming the barriers to inquiry practice are available. But what if there are other significant influences that have not been thoroughly investigated?

Purpose of the Study

Inquiry-based teaching requires careful attention to creating learning environments and experiences where students can confront new ideas, deepen their understandings, and learn to think logically and critically about the world around them (Brown, 2000). An effective learning environment is one that is "flexible in matching individual students needs with variations in instructional format and processes, including content, organization, strategies, and social settings" (Lambert and McCombs, 1998, p. 471). Classroom management and control are key components of all learning environments and can be particularly challenging at the middle school level where students are flexing their independence muscles as their minds and bodies experience changes. An important impediment as to why teachers fail to engage students in inquiry-oriented activities is the maturity level of students and the extent to which these students waste time in unstructured settings (Baker et al., 2002; Constenson & Lawson, 1986).

Maintaining control while providing a student-centered model of instruction challenges teachers' skills. Teachers who lack confidence in their classroom management skills may opt for tighter control over their classroom at the expense of inquiry activities. In their case study, Lee and Houseal (2003) found that low self-efficacy was characterized by an authoritative, teacher-centered approach consisting of text-based instruction and individual seat work rather than group work. Teachers with high self-efficacy are more likely to use inquiry and student-centered instructional strategies (Finson, 2001; Marshall et al., 2007; Ramey-Gassert, Shroyer & Staver, 1996). Beliefs as personal constructs guide teachers' instructional decisions and influence classroom management (Roehrig & Luft, 2004). Furthermore, Roehrig and Luft assert the importance in understanding the teaching beliefs of teachers because their beliefs ultimately connect to their practice.

This study utilized a non-experimental correlational design to examine middle school science teachers' background and the relationships this has with teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control. Because science inquiry activities involve greater classroom control skills by the instructor as opposed to teacher-centered, direct instruction, the relationship between teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control framed the research questions for this study.

Research Questions

This study asks the following research questions:

Research Question 1: What specific areas of 7th and 8th grade science teachers' background predict teachers' efficacy toward teaching science as inquiry?

Research Question 2: What specific areas of 7th and 8th grade science teachers' background predict teachers' attitudes and beliefs on classroom control?

Research Question 3: What is the relationship between 7th and 8th grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control?

Research Hypotheses

Hypothesis 1: 7th and 8th grade science teachers' efficacy towards teaching science as inquiry will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

Hypothesis 2: 7th and 8th grade science teachers' attitudes and beliefs on classroom control will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

Hypothesis 3: 7th and 8th grade science teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs on classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry.

Delimitations/Limitations

The present study involved only science teachers in Montana that teach grades seven and eight. Science is a core subject included in all Montana seventh and eighth grade school programs (Nielson, 2001). Seventh and eighth grade science teachers were chosen for this study because little research has addressed teacher self-efficacy toward teaching science as inquiry at these grade levels even though numerous research has dealt with the how-to of science inquiry teaching (Ango, 2002; Chiappetta & Adams, 2004; Crawford, 2007; Haury, 1993; Moscovici, 1999; Moscovici & Nelson, 1998; Ross et al., 2005). The middle school configuration in the state varies from grades four-eight, grades five-eight, grades six-eight, and grades seven-eight. The number of schools corresponding to these configurations is one, three, 29 and 177, respectively, for a total of 210 schools that meet the middle school definition (Montana Office of Public Instruction, 2007).

Although there are upwards of several hundred middle school science teachers that are potential participants, the study is limited by the number of respondents. Non-respondents are always problematic since their lack of participation can affect the conclusions drawn from the analysis of the data. Since this study only collected data from Montana schools with seventh and eighth grade student populations, generalizability to schools outside Montana is limited. Because teacher qualifications can vary widely at the middle school level, this condition affects the homogeneity of the sampled population.

Responses to survey questions can be of concern since respondents can potentially answer questions not as they see themselves, but as they'd like to see themselves. Firsthand observations of the respondents teaching practices could provide validation of survey responses. However, given the logistical challenges due to the immense geography of the state of Montana combined with the time necessary to observe teachers, observations were not a part of this study.

The return rate of survey responses can often be an issue. Surveys were mailed to 210 schools targeting 303 teachers. Unlike many surveys that go directly to the intended participants, the surveys in this study were addressed to the principals of the schools with great hopes that the principals would then pass the surveys on their science teachers. Because of the solicitation of principal approval, the potential existed that surveys may not have reached all teachers.

Definition of Terms

Inquiry: The definition for inquiry in this study is that which is provided in the *National Science Education Standards: A guide for Teaching and Learning* (National Research Council, 2000) and reads:

> 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 already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations. (p. 23)

Self-efficacy: Self-efficacy is a situation specific construct that addresses people's beliefs regarding their abilities to produce specific levels of performance toward designated tasks (Bandura, 1977). Teachers in this study with scores above the sample mean on the Teaching Science as Inquiry (TSI) instrument will be identified as having high self-efficacy toward teaching science as inquiry and those with scores below the sample mean on the TSI instrument will be identified as having low self-efficacy toward teaching science as inquiry.

Classroom Management and Control: The construct of classroom management and control is generally agreed upon to contain the components of teacher actions necessary to create and regulate order, engage students, and/or extract students' cooperation (Emmer & Stough, 2001). While varying degrees can be observed, teachers' attitudes and beliefs toward classroom control are defined as either being more controlling or less controlling in their classroom management. Used in conjunction with this are the terms interventionist and non-interventionist. Interventionist management occurs when a teacher adheres to a strict set of control guidelines from which there is little variance (Chambers & Hardy, 2005). Non-interventionist management is at the other end of the continuum in which teachers are much less controlling of students and promote a student-centered learning environment. Teachers in this study with scores above the sample means on the Instructional Management (IM) and People Management (PM) subscales of the Attitudes and Beliefs on Classroom Control-Revised (ABCC-R) instrument will be identified as more controlling in their classroom management whereas those teachers with scores below the sample means on the two subscales will be identified as being less controlling.

Teacher Background: Teachers' background will include age, gender, ethnicity, educational level, major and minor areas of study, teaching endorsement(s), years of teaching experience, years of service at present science teaching position, grade level(s) taught, hours of preparation time provided per week (prep period time), hours of science inquiry professional development and experience working with a scientist and/or in a research environment.

Seventh and Eighth Grade School Science: The target population of teachers to be surveyed will be those who teach science at these levels. Science at these levels in Montana is usually taught as the equivalent of one class period every school day.

Significance of the Study

Much of the research concerning self-efficacy in science teaching has involved pre-service teachers (Bleicher & Lindgren, 2005; Cannon & Scharmann, 1995; Cantrell, Young & Moore, 2003; Smolleck, Zembal-Saul, & Yoder, 2006; Tosun, 2001), elementary teachers (Andersen, Dragsted, Evans, & Sorensen, 2004; Fulp, 2002; McDevitt, Heikkinen, Alcorn, Ambrosio, & Gardner, 1993; Tobin, Briscoe, & Holman, 1990), and is mostly concerned with aspects of confidence and preparedness. Smolleck and Yoder (2006) claim that if it is desired that teachers teach science as inquiry, they must possess positive self-efficacy skills. Saam, Boone and Chase (1999) provided a snapshot of science teachers' self-efficacy at the upper elementary and middle school levels and Desouza, Boone and Yilmaz (2004) investigated general science teaching self-efficacy and outcome expectancy beliefs of elementary and middle school teachers in India. Brouwers and Tomic (2000) examined teacher burnout and self-efficacy in classroom management. Getting closer to the topic, Gencer and Cakiroglu (2007) conducted a study investigating the relationship between science teaching efficacy beliefs and beliefs toward classroom control. However, the construct of self-efficacy towards teaching science as inquiry and teachers' attitudes and beliefs on classroom control was not a component of their study. Marshall et al. (2008) examined K-12 mathematics and science teachers' beliefs about the use of inquiry in the classroom. The inquiry instruction self-efficacy instrument used in their study consisted of only a four-item subscale. The 34-item self-efficacy toward teaching science as inquiry instrument that was employed in the present study probed deeper into this construct. Therefore, no study has exclusively addressed the beliefs of practicing seventh and eighth grade science teachers and the relationship between their self-efficacy toward teaching science as inquiry and their beliefs and attitudes on classroom control.

Identifying the factors that either prohibit or promote science teachers' practice of inquiry in their classrooms provides the key towards addressing this important issue. As influences are identified, steps can be taken to help teachers adjust their instruction to include inquiry to a greater extent. Even if teachers are receiving pre-service training, professional development, or responding to policy mandates, these items alone might not be enough to meet teachers' needs. If changing management and control practices can lead to greater teacher efficacy towards teaching science as inquiry, then management and control skills becomes a part of the inquiry promotion equation. Learning more about why expectations for middle school science teachers fall short in implementing and executing inquiry-based instruction opens the door wider in moving the science education reform objectives forward.

Outline of the Study

Chapter 2 of this study examines research related to science inquiry, the construct of self-efficacy, attitudes and beliefs toward classroom control, and teacher background. The third chapter addresses the methodology employed to investigate the relationships between teacher background, teacher efficacy toward teaching science as inquiry and the attitudes and beliefs on classroom control. Results from the descriptive and inferential statistical analyses of the collected data are presented in Chapter 4. Found in Chapter 5 are a summary of the study, a report of the findings, a discussion of the conclusions drawn from this research, implications for science inquiry instruction, and suggestions for further research.

CHAPTER 2 - LITERATURE REVIEW

Introduction

The review of the literature examines relevant research that pertains to science teachers' self-efficacy toward inquiry-based instruction and how this relates to their classroom control attitudes and beliefs and background experiences. The literature review is divided into the following sections: inquiry, self-efficacy, classroom control, and teacher background.

Inquiry

"Inquiry is in part a state of mind – that of inquisitiveness"

(Alberts, as cited in National Research Council, 2000, p. xii).

Inquiry can have different meanings to different people. It can range from anything that is "hands-on" to "discovery" to the application of the "scientific method" and can invoke a variety of interpretations among people, even science education professionals (Hackett, 1998). Abd-El-Khalick (2004) claims that even within the NSES, inquiry is not operationally defined. Veteran science teachers as former students of the post-Sputnik era frequently have different viewpoints of inquiry than those taught in contemporary teacher preparation programs (Barrow, 2006). And yet, while many teachers have a false conception of inquiry (Anderson, 2002), when interviewed individually, upper elementary through high school teachers of science surprisingly defined authentic inquiry similarly (Marlow & Stevens, 1999).

Novak (as cited in Haury, 1993) defines inquiry as "the [set] of behaviors involved in the struggle of human beings for reasonable explanations of phenomena about which they are curious." Simply stated, inquiry involves activities that search for knowledge or understanding in an effort to satisfy curiosity.

Inquiry and Historical Context

No other person had more influence on the reform of science education in the first half of the twentieth century than John Dewey. The idea that inquiry should be included in the K-12 science curriculum was strongly recommended by Dewey (1910, as cited in Barrow, 2006). Dewey felt that science educators delivered instruction as facts consisting of a "large mass of purely technical and symbolically stated information" that fell short in moving students towards understanding and applying science (Dewey, 1916, p. 170). Teaching science through the process of inquiry promotes scientific reasoning and according to Dewey (as cited in Rudolph, 2003), inquiry "consists of the special appliances and methods which the race has slowly worked out in order to conduct reflections and conditions whereby its procedures and results are tested" (p. 69). Dewey's Laboratory School at the University of Chicago provided students opportunities to apply the scientific method to learning science in order to satisfy students' "impulses and tendencies to make, to do, to create, to produce" (Fraser, 2001, p.206). While Dewey had his critics, his perspective as to how science should be taught is the foundation of today's promotion of teaching science as inquiry.

Joseph Schwab, like Dewey, embraced the belief that the processes of inquiry were the key to science instruction and carried the torch for science inquiry during the middle of the twentieth century. Schwab felt that science should be taught in a manner that mimics the way that modern science operates; including laboratory investigations, the analysis of research reports, and the interpretation of data (Barrow, 2006).

According to DeBoer (1991), “If a single word had to be chosen to describe the goals of science educators during the 30-year period that began in the late 1950’s, it would have to be INQUIRY” (p. 206). It was not until October 4, 1957, that our nation was forced to take a hard look at the K-12 science curriculum and the quality of our science educators. The launching of Sputnik I produced an injection of funding into science education and an attitude that students should be thinking like a scientist (National Research Council, 2000). Work to compile three major NSF sponsored projects into Project Synthesis began in 1978 to investigate the actual state and desired state of science education. At that time it was estimated that 90-95% of the 12,000 teachers surveyed relied upon textbooks for their major curriculum resource (Blosser, 1981). What students should be able to do by the time they graduated from 12th grade was identified by the American Association for the Advancement of Science in the Project 2061 report of 1989 (Rutherford & Ahlgren, 1989). Described in this document were the goals for teaching science as inquiry and included the components of research questions, collection of evidence, clear expression of findings, working in teams and the limiting memorization of scientific vocabulary. More recent support for teaching science as inquiry is included in the National Science Education Standards (NRC, 1996), Inquiry and the National Science Standards: A Guide for Teaching and Learning (NRC, 2000) and the Atlas of Scientific Literacy (AAAS, 2001).

Essential Features of Inquiry

With a working definition of inquiry in place, the what, when and how of teaching through inquiry is provided by the National Science Education Standards (NRC, 1996). However, these teaching standards are broad to the extent that further narrowing down the role that inquiry plays as teachers address the standards is necessary. In order to provide consistency; the NRC (2000) identifies five essential features of inquiry that are applicable to all grade levels:

1. Scientifically oriented questions that will engage students;
2. Evidence collected by students that allows them to develop and evaluate their explanations to the scientifically oriented questions;
3. Explanations developed by students from their evidence to address the scientifically oriented questions;
4. Evaluation of the explanations, which can include alternative explanations that reflect scientific understanding; and
5. Communication and justification of their proposed explanations.

All five of these essential features are present when the full use of inquiry is conducted. However, the extent to which each is present in a learning activity can vary. Not all inquiry activities are created equal and different models for conducting inquiry are available.

Models and Phases of Inquiry

The variation to which teachers facilitate inquiry teaching and learning are based on the amount of learner self-direction versus the amount of direction from the teachers or teaching materials as shown in Table 1 (NRC, 2000).

Table 1

Essential Features of Classroom Inquiry and Their Variations

Essential Feature	Variations			
1. Learner engages in scientifically oriented questions	Learner poses a question	Learner selects among questions, poses new questions	Learner sharpens or clarifies question provided by teacher, materials, or other source	Learner engages in questions provided by teacher or other source
2. Learner gives priority to evidence in responding to questions	Learner determines what constitutes evidence and collects it	Learner directed to collect certain data	Learner given data and asked to analyze	Learner given data and told how to analyze
3. Learner formulate explanations from evidence	Learner formulates explanation after summarizing evidence	Learner guided in process of formulating explanations from evidence	Learner given possible ways to use evidence to formulate explanation	Learner provided with evidence
Learner connects explanations to scientific knowledge	Learner independently examines other resources and forms the links to explanations	Learner directed toward areas and sources of scientific knowledge	Learner given possible connections	
Learner communicates and justifies explanations	Learner forms reasonable and logical argument to communicate explanations	Learner coached in development of communication	Learner provided broad guidelines to use sharpen communication	Learner given steps and procedures for communication
More - - - - - - - - - - - - - - Amount of Learner Self-Direction - - - - - - - - - - - - - - Less				
Less - - - - - - - - - Amount of Direction from Teacher or Material - - - - - - - - - More				

Source: National Research Council (2000), p. 29

No single model is appropriate in all situations for all students or even all teachers. Teacher and student background, teaching goals, and miscellaneous factors such as time and materials influence which model fits the best practice for the investigation of specific science concepts. The Northwest Regional Educational Laboratory (2002) lists three models of inquiry:

1. Structured Inquiry – Teacher provides instructions but the students are engaged in hands-on activities in which they draw conclusions.
2. Guided Inquiry - Teacher chooses the research question but the students design the procedure for the investigation.

3. Student-initiated Inquiry – Students generate their own research questions and design their own investigations.

Martin-Hansen (2002) lists four ways inquiry is conducted:

1. Open or full inquiry – This is a student-centered approach in which students ask a question then design and conduct an investigation or experiment which they communicate their results.
2. Guided inquiry – Usually the teacher chooses the research question then aids the students in how to proceed in the investigation.
3. Coupled inquiry – This type of inquiry combines guided-inquiry with open-inquiry (Dunkhase as cited in Martin-Hansen, 2002; Martin, 2001).
4. Structured inquiry – This is typically a cookbook investigation in which students follows teacher directions ending in a specific product.

The complexity of an inquiry investigation challenges students to think like scientists. A logical sequence of events begins with the background experiences that students bring with them to the inquiry investigation and culminates with students' reflection of what they learned compared to what they knew when they started. The Northwest Regional Educational Laboratory (2002) describes the four major phases to an inquiry investigation as:

1. Connecting – which provides a phenomena to students in which they link their experience and prior knowledge to an investigation of a testable question.
2. Designing – which is a process in which students map out the plan they will use to make their investigation through data collection

3. Investigation – which is the process in which students collect, organize and report their data.

4. Constructing Meaning – which involves the analysis of students' findings and provides opportunities to formulate explanation and reflect upon the inquiry process they employed.

In Figure 1, Reiff, Harwood, and Phillipson (2002) offer their alternative to the four- or five-step traditional scientific method. This inquiry wheel provides a process that is richer and less rigid than the linear scientific method.

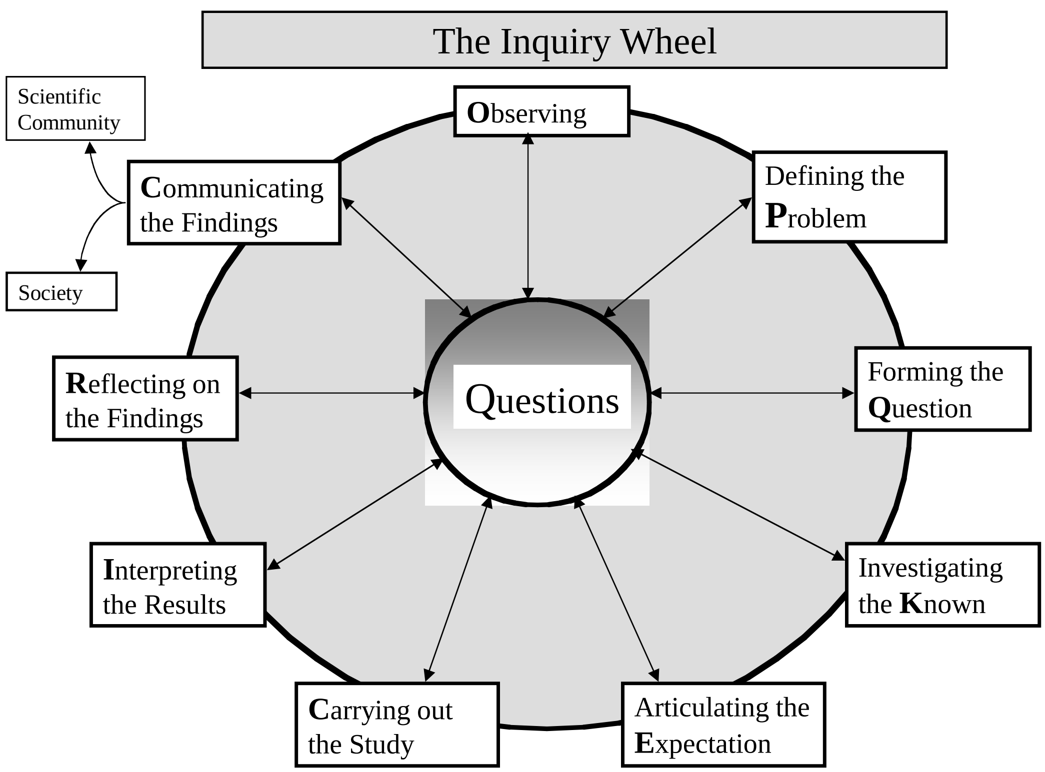

Figure 1 Inquiry Wheel

Source: Reiff, Harwood, and Phillipson (2002), p. 11

Teachers have several inquiry models to use as resources when considering the best template for the inquiry activities that their students will be engaged in. Each model supports the inquiry process, the essential features of inquiry, and is consistent with the national science standards. The National Resource Council (2000) recommends that students have opportunities to experience all forms of inquiry in the course of their science learning.

Support for Inquiry

The benefits from inquiry-based are well documented and include a greater understanding of content knowledge (Zohar & Nemet, 2003), a change in students' views of science (Bell & Linn, 2000), the enhancement of skills involving the justification of students' written claims from science investigations (McNeill, Lizotte, Krajcik & Marx, 2006) and the connection to everyday experiences (Luft, Bell & Gess-Newsome, 2008). Inquiry-oriented programs in middle school grades have been found to enhance student performance in science (Mattheis & Nakayama, 1988). Odubunmi and Balogun (1991) report that average- and low-ability students who were taught science via inquiry methods performed significantly better on science assessments than students from the same population who were taught using traditional lecture methods. Inquiry-based instruction may be especially valuable for many underserved and underrepresented student populations (Haury, 1993; Kahle, as cited in Supovitz, Mayer, & Kahle, 2000). McNeill and Krajcik (2008) argue that akin to the scientists who explain phenomena and make new claims, students as scientifically literate citizens need opportunities to engage in similar inquiry experiences. Students with an inquiry background have the ability to be critical examiners of a variety of issues and consequently make better informed decisions.

An important component of inquiry-based instruction is the opportunity for students to work together to investigate research questions. When engaged in productive, small cooperative group activities, students' problem-solving abilities and concept development are enhanced (Lumpe, 1995). Effective student groupings in inquiry-based activities increase involvement, increase productivity and result in fewer behavioral problems (Chiappetta & Koballa, 2006). These cooperative learning groups improve achievement and mastery of content (Slavin, 1989/1990), develop team-building and promote a positive classroom environment (Kagan, 1989/1990) as well as produce science learning at higher cognitive levels (Chang & Mao, 1999).

Criticism of Inquiry

For all the evidence supporting inquiry-based instruction, there are critics. While inquiry suggests discovery learning, Mayer (2004) warns against pure discovery with hands-on activities because of the risk of failing to come into contact with the to-be-learned material. Inquiry investigations often fail to address targeted key ideas and are often add-ons that are not linked to the key ideas or aid in further learning about specific content (Chiappetta & Adams, 2004; Kesidou & Roseman, 2002). For inquiry to be effective and raise student achievement, it can't be practiced haphazardly. Pre-packaged, hands-on activities with a definite beginning, middle, and end, while convenient for teachers, do not provide the process that allows students to search for patterns and relationships about the world around them (Moscovici & Nelson, 1998). What inquiry is *not* is the traditional didactic approach of lecture, textbook exercises and worksheets that many science teachers employ (Eick & Reed, 2002).

Self-efficacy

Many factors, including parents, peers, community, and culture, influence the behaviors that lead to student achievement in school, but the one common denominator in the academic equation is that of the classroom teacher. Teachers bring many items into the classroom including their attitudes, motivation, experience, and content and pedagogical knowledge. Teachers make decisions, often minute by minute, that can advance or impede what students learn in class that day. Within educational research, teacher self-efficacy has gained notable momentum as an important factor that shapes teachers' practices. Because people act upon what they believe, beliefs not only provide insight into teachers' approach to instruction, beliefs can also aid in the prediction of teaching and learning outcomes (Lumpe, Haney, & Czerniak, 2000).

Development of the Self-Efficacy Construct

Teacher's sense of efficacy was first explored and measured by the researchers from RAND Corporation in the mid-1970s. This idea was based on Rotter's 1966 theory of the locus of control which addressed internal and external control of teachers' perceptions of their capabilities to teach (Dellinger, Bobbett, Olivier, & Ellet, 2008). Efficacy was defined by the RAND researchers as the "extent to which the teachers believe he or she has the capacity to affect student performance (Berman, McLaughlin, Bass, Pauly, & Zellman, 1997, p. 137, as cited in Savran & Cakiroglu, 2003). The RAND studies acted as the vehicle for moving research in teacher efficacy forward for several years before researchers began applying Bandura's social cognitive theory and his construct of self-efficacy to education.

Bandura described self-efficacy as people's beliefs regarding their abilities to produce specific levels of performance toward designated tasks (Bandura, 1977). He claimed that these beliefs affect how people feel, think, behave and motivate themselves. Bandura identifies four ways that people can develop self-efficacy:

1. Mastery – Seeing failures as informational rather than demoralizing and learning from the overcoming of obstacles.
2. Social Modeling – Observing the success of others like themselves.
3. Social Persuasion – This occurs when people are persuaded that they have the abilities to be successful.
4. Somatic and Emotional States – This is when one reads his or her own physical and emotional states correctly in order to judge capabilities.

Using Bandura's self-efficacy construct, Ashton and Webb (1986, as cited in Gencer & Cakiroglu, 2001) developed a model which assessed two dimensions of teacher efficacy – outcome expectancy and self-efficacy expectations. Outcome expectations focus on one's beliefs that a behavior will likely lead to specific outcomes whereas self-efficacy if the belief one has about his or her ability to successfully perform a behavior. A push to develop other instruments to measure teachers' efficacy beliefs followed. Gibson and Dembo (1984) designed a 30-item Likert-type teacher efficacy scale in order to measure personal teaching efficacy and general teaching efficacy. While this scale has been one of the most popular instruments in teacher efficacy research, it has had problems both conceptually and statistically (Tschannen-Moran & Hoy, 2001).

Riggs and Enochs (1990) incorporated Bandura's self-efficacy definition of being a situation-specific construct in their Science Teaching Efficacy Belief Instrument

(STEBI). This survey tool identified two distinct dimensions – personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). The PSTE component examined elementary science teachers' confidence towards teaching science whereas the STOE measured these teachers' beliefs about how instruction affects student learning. More instruments that addressed specific subject–matter emerged. Emmer (1990) developed a classroom management instrument that consisted of three efficacy subscales – efficacy for classroom management and discipline, external influences, and personal teaching efficacy. For special education applications, Coladarci and Breton (1997) modified Gibson and Dembo's instrument. Numerous other self-efficacy measurement tools have been designed and a guide for constructing self-efficacy scales has been suggested by Bandura (2006b).

Tschannen-Moran and Hoy (2001) examined many of the self-efficacy instruments and noted the problems and challenges associated with each. They responded by developing a new measure of self-efficacy which they named the Ohio State Teacher Efficacy Scale (OSTES). This instrument addressed efficacy for instructional strategies, efficacy for classroom management, and efficacy for student engagement. Results from their research indicated that this instrument was both reasonably valid and reliable. But as the authors pointed out, self-efficacy remains an elusive construct to capture and self-efficacy scales need further testing and re-examination thus opening the doors for new research.

Features of the Self-Efficacy Construct

Self-efficacy is a situation specific construct that addresses the "beliefs about one's capabilities to execute courses of action required to deal with prospective situations"

(Bandura, 1982, p. 122). Associated with self-efficacy is outcome expectancy that Bandura (1977) describes as "a person's estimate that a given behavior will lead to certain outcomes" (p. 79). Self-efficacy is not to be confused with other "self" constructs such as self-esteem and self-concept. These terms address judgments of one's own worth (Bong, 2006) and a person's perception of himself (Shavelson, Hubner & Stanton, 1976).

The teacher self-efficacy model presented by Tschannen-Moran et al. (1998, p. 228) in Figure 2 depicts the interaction of teachers' processing of teaching tasks and self-assessment of teachers' abilities to accomplish tasks which results in teachers' efficacy judgments. Teachers' judgments then in turn affect how they go about setting goals, make decisions regarding effort, and persist when difficulties arise. Figure 2 also includes the relationship of the four sources of efficacy described by Bandura (1977).

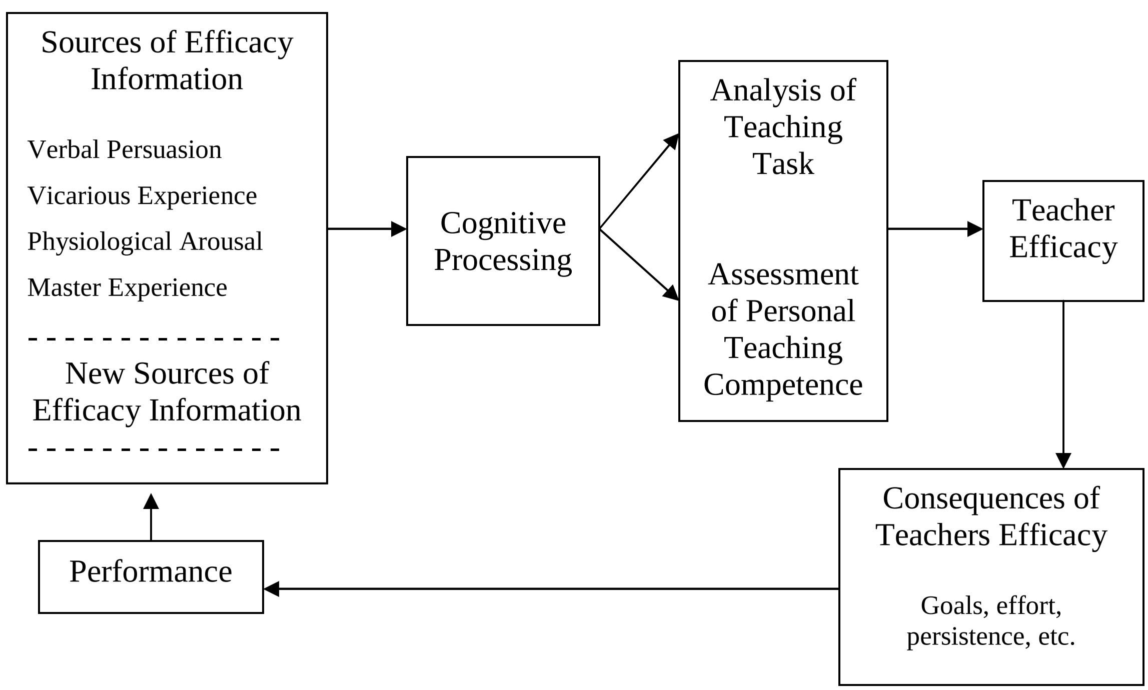

Figure 2 The cyclical nature of teacher efficacy

Source: Tschannen-Moran, Woolfolk Hoy, & Hoy (1998), p. 228

The cyclical nature of teachers' efficacy judgments can significantly shape teachers' beliefs and behaviors. For example, if teachers have positive experiences, their mastery experience is a source that can elevate their self-efficacy. Increased self-efficacy nourishes persistence and effort which further supports higher self-efficacy beliefs. Conversely, less than desirable experiences can trap teachers in a cycle of lower self-efficacy.

Bandura (1997) claims that the best indicator that relates to the decisions that people make result from their beliefs. Assessment of self-efficacy involves addressing the very beliefs that people utilize when they encounter situations involving the need for specific actions or performance (Pajares, 1996). While beliefs can influence attitudes, values and judgments, they are not to be confused with them. Attitudes can be developed from beliefs that in turn can guide decisions and behavior (Pajares, 1992).

Impact of Self-Efficacy on Teaching and Learning

The instructional practices of teachers are related to their efficacy beliefs (Pajares, 2002). Many attributes of teachers with high self-efficacy have been noted (Ashton & Webb, 1986; Chacon, 2005; Gibson & Dembo, 1984; Guskey, 1998; Muijs & Reynolds, 2001; Stein & Wang, 1988; Woolfolk Hoy & Davis, 2006) and these teachers tend to:

- exhibit greater enthusiasm towards teaching,
- spend more time planning and organizing lessons,
- be more open to new ideas and unique teaching strategies,
- use inquiry and other challenging techniques,
- be less likely to rely on lecture in their instruction,
- be less controlling with regards to discipline,

- display more persistence in the face of difficulties,
- experiment more with their instructional methods,
- display more understanding when students make errors,
- believe they can be successful with students who possess behavioral and/or learning problems, and
- be less concerned with covering the curriculum and more concerned with keeping students engaged.

In short, teachers with high self-efficacy beliefs about their abilities to manage and conduct their classroom instruction put forth the effort needed to meet the needs of their students and do so with vigor and determination while being open-minded, flexible and compassionate.

The effects of a highly efficacious teacher on his or her students is wide-ranging and produces many benefits to students' learning and social outcomes (Anderson, Greene & Loewen, 1998; Moore & Esselman, 1994; Midgley, Feldlaufer, & Eccles, 1989; Mujis & Reynolds, 2001; Ross, 1992; Ross, Hogaboam-Gray & Hannay, 2001; Woolfolk Hoy & Davis, 2006). Teachers with a high self-efficacy impact students' educational experience by:

- having students who outperform students with less efficacious teachers,
- elevating students' own sense of efficacy,
- developing deeper, meaningful relationships with students,
- re-teaching more often when necessary,
- setting learning targets that are clear to students,
- providing prompts and allowing more time for students to answer questions,

- allowing students a role in the decision-making process,
- inspiring intrinsic motivation in students,
- modeling active and strategic approaches to problem-solving, and
- impressing upon students an understanding of lifelong learning.

Since science teachers' beliefs affect their decisions and actions, these beliefs play a role in all components of their teaching including the extent to which they promote and practice inquiry-based instruction.

Classroom Management and Control

Classroom Management and Control as a Construct

Classroom management and control has been cited as a major concern of teachers of all levels of experience (Goyette, Dore, & Dion, 2000) and has been the primary reason beginning teachers resign from their teaching position after a relatively short career (Ingersoll & Smith, 2003). Research on classroom management and control has increased significantly over the past few decades as educators recognized the importance of this construct to the overall learning process (Emmer & Stough, 2001). With new information, new strategies and techniques have emerged to assist teachers in becoming more effective educators. Yet in spite of the advancements made in classroom management and control, Parsad, Lewis and Farris (2000) report that of the teachers surveyed, 45% felt that they lacked the preparation needed in classroom management strategies.

The terms discipline and classroom control are often used synonymously, however, they are not the same. Discipline refers to students' compliance with rules while management addresses learning, social interaction and general student behavior (Martin, Yin, & Baldwin, 1998a). Salvia & Ysseldyke (1998) claim that "classroom management refers to a collection or organizational goals centered on using time wisely to maximize learning and on maintaining a safe classroom environment that is conducive to student learning" (p. 30).

Jones (1996, as cited in Emmer & Stough, 2001) identifies five main features of comprehensive classroom management:

1. An understanding of current research and theory in classroom management and students' psychological and learning needs.
2. The creation of positive teacher-student and peer relationships.
3. The use of instructional methods that facilitate optimal learning by responding to the academic needs of individual students and the classroom group.
4. The use of organizational and group management methods that maximize on-task behavior.
5. The ability to use a range of counseling and behavioral methods to assist students who demonstrate persistent or serious behavior problems (p. 507).

All of these features have application to the effective facilitation of inquiry-based instruction.

Classroom management and control style is a construct that can be defined in three dimensions – instructional management, people management and behavior management.

1. Instructional management – addresses the approach teachers' use to establish general classroom atmosphere and describes teachers' style of classroom management (McNeely & Mertz, 1990).

2. People management – addresses the extent and quality to which teachers develop and nurture teacher-student relationships (Weinstein, 1996). Weinstein asserts, "Teachers are good when they take the time to learn who their students are and what they like, when they laugh with their students, and when they are both a friend and a responsible adult" (p. 76).

3. Behavior management – while similar to discipline, the behavior management dimension is more concerned with the prevention of misbehavior and provides opportunities for student input as well as a reward system for appropriate behavior (Martin et al., 1998a).

Classroom management and control is operationalized as the behavior tendencies that teachers use to conduct their daily instruction and include teacher's instructional style, communication with students, and classroom spatial management. All of these items provide evidence as to choices teachers make in order to meet the instructional learning goals. While the construct of classroom control may have not reached the status of a consensus, it is generally agreed upon to contain the components of teacher actions necessary to create and regulate order, engage students, and/or extract students' cooperation (Emmer & Stough, 2001).

Classroom Control and Self-efficacy

An important variable in teachers' classroom control approach is their self-efficacy. This has been defined by Tschannen-Moran and Hoy (2001) as a teacher's "judgment of his or her capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated" (p. 31). Self-efficacy beliefs are domain specific and classroom control represents an important domain affecting the facilitation of inquiry-based instruction.

High efficacious teachers assume a responsibility toward helping their students with behavior challenges in the classroom as opposed to low efficacious teachers who spend less time assisting students with their behavior problems (Dembo & Gibson, 1985; Hughes, Grossman, & Parker, 1990). Teachers with low personal self-efficacy have been found to be more critical of their students and give up when faced with difficulties (Gibson & Dembo, 1984). Likewise, these same teachers tend to practice classroom control from a position of authority and are much more controlling (Ashton & Webb, 1986). In contrast, teachers with high self-efficacy follow more humanistic student control practices (Woolfolk & Hoy, 1990) and develop more positive relationships with their students (Rich, Lev, & Fisher, 1996) leading to less control and being more open-minded toward students' perspectives (Woolfolk-Hoy & Davis, 2006). Morris-Rothschild & Brassard (2006) found that teachers with an obliging style of classroom control had high classroom management efficacy. These unexpected results may be the result of teachers not having the skills necessary to execute the tasks that they feel confident about performing (Bandura, 1986).

Classroom management and control interactions can be described in three dimensions: non-interventionist, interventionist, and interactionalist (Chambers & Hardy, 2005). A non-interventionist is characterized as a teacher who is less controlling and allows students to be expressive and play a role in the classroom decision-making processes. By contrast, the interventionist is very controlling and conducts classroom management procedures according to a set of specific, structured guidelines and rules. Interactionalists believe in shared responsibilities between the teacher and students. Reeve and Jang (2006) identify two approaches related to the classroom management climate: autonomous and controlled. When teachers encourage autonomy, they provide students the opportunity to align their inner motivational resources with the classroom activities. Teachers who are more controlling guide students to a teacher-centered agenda that discourages students from independent knowledge construction. The classroom management beliefs and actions of controlling teachers run counter to the ideas of learning science through inquiry.

Classroom Control and Inquiry-based Instruction

Quality teaching occurs when classroom management and control are coordinated simultaneously with quality instructional methods (Emmer & Stough, 2001; McCormack, Gore & Thomas, 2006). Inquiry-based instruction without proper management strategies reduces the effectiveness of the inquiry experience. Student autonomy is an important component of learning by inquiry and teachers with high self-efficacy beliefs are more likely to provide and foster autonomous learning environments (Leroy, Bressoux, Sarrazin, & Trouilloud, 2007). Because students are given more responsibility in making decisions in inquiry-based lessons, the potential for students making poor decisions beneath the classroom management umbrella is greater than that found in tightly controlled teacher-lead instruction. Inquiry-based instruction is attached to the concept of teaching to the whole child and teachers whose pedagogy embraces teaching to the whole child are often the most effective at managing their classrooms (Miller & Pedro, 2006).

The research literature is rich with the nuts-and-bolts of “how to” conduct inquiry-based lessons (Beerer & Bodzin; 2004; Chiappetta & Adams, 2004; Crawford, 2007;

Hinrichsen & Jarrett, 1999; Lord & Orkwiszewski, 2006; Moscovici, 1999; Moscovici & Nelson, 1998; Volkmann & Abell, 2003). While far less research exists on classroom management and control for inquiry, Lawson (2000) discusses the problems and solutions for helping teachers attain success with their inquiry lessons. In his study, teaching assistants at Arizona State University were asked to identify and rank the classroom management problems they encountered with their students in biology labs. Fifteen student behaviors were identified and it was noted that some students (p. 642):

1. do not participate enough (serious problem).
2. do not know how to get the inquiry started (serious to moderate problem).
3. do not care and do not see the inquiry as relevant to their lives (serious to moderate problem).
4. do not listen (moderate problem).
5. lack background knowledge for inquiries (moderate problem).
6. talk at inappropriate times (moderate problem).
7. have bad attitudes and are disruptive (moderate problem).
8. are doing poorly and want extra credit (moderate problem).
9. do not want to think for themselves – they just want to know the right answer (moderate problem).
10. are bored and inattentive (moderate to slight problem).
11. socialize during lab (moderate to slight problem).
12. participate too much (moderate to slight problem).
13. do not clean up after themselves (moderate to slight problem).
14. cheat and plagiarize the work of others (moderate to slight problem).

15. are tardy and leave early (slight problem).

Lawson provides solutions to each of these problems in his discussion. For example, with regards to socializing during laboratory investigations he recommends that the teachers should circulate around the room and watch and listen to what they students are doing and saying. This sends a message that their activities are being monitored. The same behavioral issues are not unlike those listed by Baker et al. (2002) who interviewed middle school teachers concerning their classroom management challenges when conducting inquiry lessons. However, with the middle school teachers, class period time limitations, classroom constraints, support from parents and the administration, and materials management were identified as serious problems when it comes to classroom management for inquiry.

The cooperative learning/group work component of inquiry-based instruction lends itself to management challenges. Teachers need to be keenly aware that expectations for both teachers and students are different in cooperative learning settings than those of traditional teacher-lead instruction. Emmer and Stough (2001) recognize two key principles of a well-managed classroom setting (p. 105):

1. Good management is preventive rather than reactive.
2. Teachers help create well-managed classrooms by identifying and teaching desirable behaviors to their students.

The juxtaposition that science teachers encounter when facilitating inquiry-based instruction contains students' freedom to explore within defined borders. Keeping students on task and moving toward the learning goals taxes even the most competent science teachers (Darling-Hammond, 2003; Malm & Lofgren, 2006). However, Cameron and Sheppard (2006) claim that a high percentage of teachers are incapable of practicing effective classroom management strategies that prevent behavioral disruptions.

Teacher Background

"The development of skills in scientific inquiry requires that students of science be provided with appropriate and adequate guidance in their study of science" (Ango, 2002, p. 11). How teachers guide their students is influenced but not limited to their teacher preparation experience, district mandates, teachers' professional development participation, work with colleagues, and overall attitudes and beliefs. Teacher knowledge that is developed by teachers to help others learn is described as pedagogical content knowledge (Shulman, 1986) and is influenced by subject matter knowledge, pedagogical knowledge, and knowledge of context (Abell, 2007). For some teachers, pedagogy is a complex tapestry of interwoven components, for others it's much simpler. What Bruner (1996, p. 54) describes as "seeing children as learning from didactic exposure" refers to the common practice of teachers teaching the way they've been taught. Unfortunately, in didactic transmission, many teachers misunderstand the nature of knowledge and are socialized to believe that the acquisition of knowledge is to be passed on to students in this manner (Brookfield & Preskill, 1999).

In order to grow as professionals, teachers must take risks and experiment with their instruction (Loughran, 2007). Even expert teachers find teaching through inquiry challenging (Krajcik, Blumenfeld, Marx, & Soloway, 1994; Marx et al., 1994). Klopfer (1991) writes, " some researchers found that teachers had difficulty translating their knowledge into practice or that teachers believed that they had implemented more good practice into their classroom than observations supported" (p. 352).

This section examines research relevant to teachers' background and experience and how these influence teacher quality, the practice of inquiry, self-efficacy, and the beliefs and strategies related to classroom management. While discussed as separate entities, these attributes impact each other and act as variables in the equation that result in the product of instruction.

Teacher Quality

Teacher background and experience are consistently examined in the research literature in terms of teacher quality. While Goldhaber and Anthony (2005) describe teacher quality as an ill-defined and oft-used term, they characterize it as "a teacher's quantifiable ability to produce growth in student achievement" (p. 6). Rice (2003) claims that teacher quality "is the most important school-related factor affecting achievement" (p. v). To illustrate this assertion, Hanushek (1992) provides an example in which students with a high quality teacher will see a learning gain of 1.5 grade level equivalents compared to a gain of 0.5 grade level equivalents with a low quality teacher during the course of an academic year. This equates to a difference of a full year in terms of academic growth.

Measuring teacher quality is inherently problematic due to certain teacher attributes that affect success but are difficult to measure, such as enthusiasm, love of learning/teaching, level of compassion for students, and dedication to education. Regardless, research in the area of teacher quality moves forward in an attempt to find associations with student performance. Rice (2003) suggests the following five areas that should be considered with regards to the assessment of teacher quality:

1. Teacher experience – in the early years of teaching, “learning by doing” has a positive effect on success.
2. Teacher preparation programs and degrees – not all college programs produce high quality teachers. Also, advanced degrees can impact teacher success, especially if these degrees were earned in the subjects that teachers teach, such as mathematics and science. Results are mixed at the elementary level.
3. Teacher certification – teacher certification in mathematics for mathematics teachers has a positive impact on their success.
4. Teacher coursework – positive outcomes are observed if coursework in specific subject areas and pedagogy are experienced. At the high school level, content coursework is very important for success in the classroom.
5. Teachers’ own test scores – students attain higher levels of achievement with teachers who scored well on literacy and verbal abilities assessment. However, scores on such tests as the National Teachers Examination are not good predictors of teacher effectiveness.

Other research elaborates on the points suggested by Rice. Years of teaching experience and the impact on student achievement is wide ranging. Teacher experience had no significant impact on student performance on more than half of the 109 related studies examined by Hanushek (1986). However, Greenwald, Hedges and Laine (1996) did find positive correlations in cases where teacher experience affected student outcome. Years of teaching experience has had the greatest impact on teacher success in the early years of teachers’ careers (Rivkin, Hanushek & Kain, 2005). This effect occurs in the first five or so years in the classroom before leveling off (Darling-Hammond, 2000).

Goldhaber and Anthony (2005) caution that teacher experience and its relation to teacher quality should be analyzed according to context and that historically teachers' years of experience "has probably been measured in such a way as to make it difficult to discern differences in teacher quality by experience level" (p. 16).

Mixed results have emerged with regards to the affect of teachers' college degrees on their teaching effectiveness. Some studies show a positive correlation with student performance and others don't (Greenwald et al., 1996; Hanushek, 1986). Goldhaber and Brewer (1997) found that advanced degrees appear to influence student achievement in mathematics and science. The problem with research on the effectiveness of advanced degrees is that only the degree is identified and not the subject of the degree (Goldhaber & Anthony, 2003a).

Teacher certification and teacher effectiveness was deeply explored in a review of 150 studies by the Abell Foundation (Walsh, 2001). This study concluded that there was no difference in effectiveness between certified and uncertified teachers. However, Goldhaber and Brewer (2000) found that in high school mathematics and science, students of fully-licensed teachers tended to attain greater achievement. Goldhaber and Anthony (2003a) conclude that the research base is not strong enough to support a position on whether or not teacher certification plays a significant role in student performance.

Teacher preparation in the areas of content and pedagogy has been the target of research but no consensus on teacher effectiveness and student performance has been reached. Problems with assessing this component of teacher background include the variation in teacher training programs and the instructional setting and philosophies where the teachers teach (Goldhaber and Anthony, 2003b).

Teacher Background and Inquiry

According to Colburn (2000), the teacher is the key element in an inquiry-based classroom. Implementing and successfully executing inquiry instruction requires science teachers to make a shift from what they may typically do in a science lesson. Colburn explains that teachers must not only support inquiry by allowing students some part in the control over what students do, the teacher should possess knowledge of the subject being investigated and have an understanding of how students learn. An inquiry-based learning environment supports high student social interaction that is risk-free and promotes the sharing of ideas through dialogue (Brewer and Dane, 2002).

The facilitation or lack of facilitation of inquiry is a complex interaction of teacher beliefs, values and understanding of the nature of science, commitment to curriculum, professional development experiences, resources, and support from administration and parents (Anderson, 2002; Crawford, 2007; French, 2005; Keys & Bryan, 2001; Marlow & Stevens, 1999). Windschitl (2003) identifies preservice teachers' experience as K-12 students, experience in college level science laboratory settings, and teacher education coursework as important influences on teachers' conceptions and beliefs toward the practice of inquiry-based instruction. Smith (as cited in Jones & Carter, 2007) contends that early experiences outside formal education may influence teachers' beliefs toward teaching science in ways greater than experienced in formal education. While teachers' beliefs and practice toward teaching science may be significantly influenced in science methods course, practices in the classroom naturally evolve as teachers see what works and what doesn't with their students (Skamp, 2001). Supporting this position are Bryan and Abell (1999) who claim that beliefs are challenged during actual teaching practice and this leads to professional growth and that the resulting professional knowledge does not materialize before the actual experience. A certain amount of on-the-job training is an inherent reality as teachers advance their skills as effective science educators. This does not undermine the importance of a quality science teacher education program and the ongoing efforts to find the best experiences to prepare teachers for the challenges that lie ahead for them.

Windschitl (2003) suggests that science methods instructors should be encouraged to provide preservice science teachers with inquiry strategies applicable for teachers' own classrooms. He emphasizes that students' past academic and professional experiences with research and their beliefs about the nature of science are important influences as to whether teachers pursue and practice inquiry-based instruction. Windschitl goes on to claim that undergraduate experiences in science inquiry mirrors that of high school experiences which Trumbull and Kerr (1993) found highly scripted and controlled.

Science methods and science content coursework can provide valuable experience in the areas of subject matter knowledge and science teaching pedagogy. However, Windschitl (2003) suggests that authentic science investigations should be a part of all teachers' preservice experience. Sadly, according to Hahn and Gilmer (as cited in Abd-El-Khalick et al., 2004), most teachers have not directly engaged in authentic scientific inquiry through their own science education experiences or through their teacher preparation programs. Almost all teachers enter teacher education programs with no past inquiry experience in which they designed and conducted an experiment to investigate a question they had developed (Shapiro, 1996; Windschitl, 2000). Shapiro's study in an elementary science methods class found that 90% of the students had not conducted a scientific investigation. Of those that did, they did so in a school science fair.

Prior research experience by inservice teachers with laboratory and real-world settings has been shown to influence the use of science inquiry in the classroom (Friedrichsen & Dana, 2005; Varelas, House, & Wenzel, 2005). In a collection of narratives describing the value of teachers' experience in engaging in authentic research alongside scientists, Brock (1999) remarked on the impact his fisheries research experience had on his views of teaching science:

> My changes as a classroom teacher and learner of science have been profound. My working paradigm of what science is and how we interact with it has principally changed to encompass science as an action to learning. Our learners must be involved mentally in the science, and as educators we have to recognize not just what is important to teach but how to best go about it as a scientist. The teaching and learning of science should be an adventure with more questions asked than answered. As individuals, we have to examine our purposes for teaching science and ask ourselves if we are involving our learners in the art or merely re-teaching the products of science. (p. 65)

Subject matter knowledge (SMK) has received a considerable of attention as it relates to science teaching practice (Abell, 2007). Harlen (1997) found that science background in SMK and the confidence to teach science are related. As it pertains to teaching science as inquiry, Newton and Newton (2001) found that based on formal education, teachers with less SMK spent more time lecturing rather than promoting inquiry-based instruction.

When faced with topics of low-knowledge experience, the participant in a study by Abell and Roth (1992) relied more on text-based lessons than engaging students in hands-on activities. Lee's (1995) case study of a middle school science teacher revealed that this teacher's limited SMK was responsible for this teacher choosing textbook-based and seatwork instead of whole class discussions. In Dobey's dissertation (as cited in Abell, 2007), the relationship between preservice elementary teachers' SMK and their level of practicing inquiry instruction was investigated. Teachers' SMK was measured based on the performance and training on topic-specific tasks. In a 5th grade pendulum unit, teachers were grouped according to "no knowledge", "intermediate knowledge", and "knowledge." The "no knowledge" group of teachers exhibited a more teacher-directed strategy when compared to the "intermediate knowledge" group but not more so than the "knowledge" group. These mixed results highlight the complexities of finding a correlation between SMK and the practice of teaching science as inquiry.

And yet, content knowledge alone is not enough to produce successful science teaching and learning experiences. Pedagogical content knowledge and reflection of students' learning are important variables in the equation. Nelson (2001) reports on a science teacher who had strong background knowledge in the sciences who achieved her transformation from a more traditional form of instruction to an inquiry-based approach once she modified her pedagogy and became reflective of her practices.

While Yager and Bonnstetter (1990) have identified the practices of teachers who have developed exemplary science programs of which inquiry is an important component, the research literature is still in need of studies that identify the situational and dispositional background experiences of teachers and how these relate to the promotion and practice of teaching science as inquiry. Teachers' experience level and how this affects the use of inquiry-based instruction has shown mixed results in prior research. Smerdon, Burkam, and Lee (1999) found more inquiry-led instruction by less experienced teachers whereas Luft (2001) discovered that beginning science teachers were less likely to engage students in inquiry-oriented lessons than experienced teachers. Abell (2007) contends that research shows the relationship between various teacher characteristics and subject matter knowledge as inconclusive and remains open for additional study. Lederman (as cited in Abd-El-Khalick et al., 2004) advocates that teacher professional development in inquiry "should include direct experiences with science as it is practiced in active research laboratories" (p. 404). Lederman concludes in claiming that research supporting the value of active research experience has not yet been made available.

Teacher Background and Self-efficacy

In the course of human activity, each new experience represents a potential for changing or reinforcing a behavior. How behaviors are addressed is related to beliefs. Instructional practices have been linked to beliefs (Gibson and Dembo; 1984; Kang, 2008; Lumpe, Haney, & Czerniak, 2000; Pajares, 2002; Tschannen-Moran & Woolfolk Hoy, 2001). Practical knowledge as it pertains to teaching refers to the beliefs and habits of teachers acquired from experience (Snider & Roehl, 2007). Self-efficacy is the construct that addresses teachers' beliefs with regards to their confidence in their abilities to design and execute a specific teaching task. A significant amount of self-efficacy is shaped during the early portions of a teachers' career (Bandura, 1977). This segment of a teaching career includes teacher preparation coursework, observations, field experiences, and time as a practicing educator. Most of the research on teachers' self-efficacy has addressed factors during that early timeframe though Jarrett (1999) reports that preservice teacher' interest and confidence in teaching mathematics and science was greatly influenced prior to this time by their own elementary experiences in these subjects. Wenner (2001) found that experience leads to greater teacher self-efficacy.

Teachers' self-efficacy impacts their decisions and how they conduct their instruction. De Laat and Watters (1995) found that science teachers with a high self-efficacy connected their instruction with students' real life experiences and emphasized hands-on activities. Pre-service science teachers with low confidence in their science teaching abilities taught didactically rather than with inquiry (Plourde, 2002; Tosun, 2000). Beginning teachers with a low self-efficacy for classroom management tend to avoid constructivist science activities and deliver what could be inquiry-based lessons as teacher-lead demonstrations (Mulholland & Wallace, 2001).

The science teaching efficacy beliefs of elementary preservice teachers were investigated by Cantrell et al. (2003). Changes in efficacy were examined during introductory methods course, during advanced methods courses, and later during student teaching. The researchers found a moderate change in efficacy among males and an improvement of efficacy with greater teaching responsibilities. This change was not observed in the female participants. Desouza et al. (2004) discovered that science teachers with a science degree had a higher self-efficacy towards teaching science than those without a science degree. These researchers also suggest that the higher self-efficacy of middle school science teachers was due to the influence of those who were experienced teachers who had mastered the content and found meaningful ways to deliver it to their students. Danish elementary science teachers were followed by Andersen et al. (2004) through their first year of teaching and it was observed that self-efficacy experienced positive changes in relation to environmental factors helpful to teaching. In Plourde's (2002) study with preservice teachers' student teaching practice, self-efficacy was not affected by this experience. However, these student teachers' beliefs that their teaching would have a positive effect on student learning deteriorated during student teaching which Plourde attributes to a variety of barriers and stresses that the participants encountered as student teachers. Contrarily, Woolfolk Hoy and Spero (2005) found significant increases in self-efficacy during student teaching. Interestingly, this study revealed a significant decline in self-efficacy during participants' first year of teaching.

Background and subject matter knowledge have been investigated as to their impact on teachers' self-efficacy. Teachers with greater background knowledge in subject matter tend to be more self-efficacious (Muijs & Reynolds, 2001). Cantrell et al. (2003) found that beginning teachers with a strong background in science have a greater self-efficacy towards their teaching of science than those with a minimal science background. However, Raudenbush, Rowan and Cheong (1992) claim that the effects of a lack of background knowledge can be mitigated with high self-efficacy. Woolfolk Hoy and Davis (2006) point out that middle school teachers' sense of efficacy may play a very important role since these teachers may be teaching several subjects that they are not deeply grounded in at a content level that is more complex than that in the elementary grades.

Bandura (1977) names four sources of self-efficacy: mastery, social modeling, social persuasion, and somatic and emotional states. These can be addressed in a variety of ways through a teacher's experiences whether they come from as far back as the way they were taught, through teacher preparation, and finally into practice in the classroom. The research literature provides varying results with regards to experience-related factors and the influence on teacher self-efficacy. Woolfolk Hoy and Spero (2005) suggest further research is needed in aiding novice teachers with self-efficacy issues and Desouza et al. (2004) would like to see novice science teachers' self-efficacy monitored through their academic preparation in order to assist with science teaching confidence. The restructuring of preservice field experiences has been identified by Mulholland and Wallace (2001) as an important means of advancing science teaching self-efficacy. These researchers suggest that field service placements should include mastery experiences that are supported under the watchful eyes of inservice supervisors. They further add the importance of appropriate modeling of science strategies by college instructors so that the preservice teachers can enhance their self-efficacy toward teaching science through vicarious experiences.

Teacher Background and Classroom Management and Control

In spite of the recognition of the importance of classroom management to student learning, classroom management persists as one of the top challenges reported by teachers (Baker et al., 2002); Goyette et al., 2000; Smith, 2000; Sokal, Smith, & Mowat, 2003). Classroom management and control encompasses a full range of efforts by teachers including all aspects of teaching and learning activities, student interactions and student behavior (Ritter & Hancock, 2007). Emmer and Stough (2001) describe classroom management as the educational strategies that cultivate teaching, learning, and discipline in the classroom. Given the importance of effective classroom management to teaching and learning, research has revealed that both novice and veteran teachers admit deficiencies in their abilities to manage classrooms effectively (Darling-Hammond, 2003; Malm & Lofgren, 2006). Darling-Hammond asserts that teacher preparation and training is the key to the development of effective management skills and pedagogy. While many classroom management models are discussed in research (Wolfgang & Glickman, 1986), one of the most widely applied ones is the model proposed by Glickman and Tamashiro (1980) and Wolfgang and Glickman. In this model, classroom management strategies are identified as being interventionist, non-interventionist, or interactionalist. Interventionists are teachers who exercise considerable control over classroom activities. Conversely, non-interventionists allow for students' expression of their inner drive with the teacher acting in an advisor role rather than as a director. Interactionalists believe in shared responsibilities between the teacher and students. Martin, Yin, and Baldwin (1998b) developed the Attitudes and Beliefs on Classroom Control (ABCC) Inventory in order to measure teachers' propensity towards being interventionist, non-interventionist, or interactionalist.

The ABCC survey consists of three dimensions: the instructional management subscale measures the daily routines such as the distribution of materials and the supervision of students working independently; the people management subscale addresses teacher-student relationships and how these are developed and maintained; and the behavior management subscale assesses the means teachers' use to prevent student misbehavior. A more recent, revised ABCC-R instrument now only contains two dimensions, instructional management and people management (Martin, Yin and Mayall, 2007). Different components of teachers' experience and situational characteristics have been investigated using the ABCC in order to examine relationships with teachers' classroom management and control strategies. Conflicting results have emerged, clearly illuminating the need for additional studies.

Prior to the ABCC instrument, Martin and Baldwin (1994) used the Inventory of Classroom Management Style (ICMS) survey to investigate the relationship between classroom management style and teaching experience. Results indicate that novice teachers were more controlling than teachers with experience. Experienced teachers tend to be more flexible with their instruction and more likely to make changes in response to new events that occur in the course of a lesson (Westerman, 1991). Novices on the other hand tend to stick with their lesson plan in spite of changing needs. Westerman also reports that student teachers adhere to a set script because they feel that they need to cover every part of a lesson before the class period ends. With regards to gender differences, Martin, Yin and Baldwin (1997) found no gender differences among the three classroom management dimensions of the ABCC and yet Martin and Yin (1997) found that females in their study were significantly less interventionist than males in the people and behavior management subscales.

More recently, Martin, Yin, & Mayall (2006) found that teachers with six or more years of experience were more controlling with regards to the subscale of instructional management but less controlling with regards to people management when compared to less experienced teachers. No significant differences with regards to gender were observed on the people management subscale in this study, but in terms of instructional management, female teachers were more controlling than male teachers. The researchers cautioned the readers in interpreting these results since the male teachers made up only

14% of the research participants. Martin et al. also observed that teachers with classroom management training scored significantly less controlling on the people management subscale compared to those teachers without management training.

Ritter and Hancock (2007) applied the ABCC instrument to their research on the relationship between certification sources, experience levels, and the classroom management strategies of 158 middle school teachers. Among the participants, 53 were experienced, traditionally certified teachers; 27 were experienced but with alternative certification; 45 were novice teachers with traditional certification; and 33 were novice teachers who were alternatively certified. Experienced teachers had completed at least five consecutive years of teaching and novice teachers had less than two years of teaching experience. Traditional teacher certification involved the completion of a four-year degree with teaching certification from an accredited college program or university teacher preparation program. Alternative certification was obtained through other means and typically consisted of less teacher education coursework. Results revealed that there was no significant difference in teacher orientation towards classroom management along the lines of certification. Also, no significant difference in teaching experience and level of control was observed. However, when certification source and years of experience were combined for analysis, traditionally certified teachers with many years of experience were significantly less controlling than those with alternative certification and fewer years of experience.

Libraries of books and research papers have been published regarding the topics of classroom management and control. Several papers have been highlighted that examine the influence of teacher experience and background on teachers' strategies toward managing their students and instruction. Inconsistencies have been noted which supports further research on this subject.

Summary

Teacher background plays an important role in what teachers teach, how they teach, and the effects on student learning. Teaching experience can logically provide insight to instruction and learning that lesser experienced teachers don't have. However, new teachers often enter the profession armed with the latest pedagogical techniques and strategies. While teacher preparation experiences have an effect on the promotion of inquiry-oriented teaching, exposure to inquiry prior to training significantly affects prospective teachers' practice of inquiry (Kagan, 1992). Regardless of teachers' background, the overall practice of inquiry-oriented instruction in today's classrooms falls short of what science education policy makers would like to see. The question persists, what is impeding the progress of the inquiry component of science education reform? Before the barriers can be brought down, they must first be identified. While some barriers have been identified, the lack of progress in the practice of inquiry suggests that there may be others that play a significant role.

This chapter presented a review of the research literature relevant to this study. The research highlighted addressed the topics of inquiry, self-efficacy, classroom management and control, and teacher background. The next chapter presents the methodology used to conduct the present study which examined middle school science teachers' background and the relationships this has with teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control.

CHAPTER 3 - METHODOLOGY

Introduction

Inquiry-based instruction is a cornerstone of the science reform movement. Yet, the practice of inquiry in science classrooms falls short for a variety of reasons. Teacher self-efficacy affects teachers' beliefs and decisions about their instruction, including the implementation of inquiry. This chapter describes the research design of this study including the population and sample, a-priori definitions, the data collection procedures, the survey instruments, and the statistical procedures used to analyze the data.

Research Design

This study utilized a non-experimental correlational design to examine the relationship between seventh and eighth grade science teachers' background, self-efficacy toward the teaching of science as inquiry and attitudes and beliefs regarding classroom control. This type of research design is appropriate because independent variables are not manipulated and participants of the study are not subject to treatments or inventions.

Population and Sample

For the purpose of this study, science teachers of grades seven and eight were targeted. There are 210 schools in Montana that fit the seventh and eighth grade criteria described in the definitions section. The Montana Office of Public Instruction (2007) lists 329 administrative units comprised of K-12, combined, independent, non-operating and state funded districts. Non-public schools are not included as part of this study due to the difference in criteria for teacher employment compared to that of the Montana public schools. Student population in grades 1-6 and 7-8 for 2006-2007 was 63,134 and 22,527, respectively. There is no data that specifically reports the exact number of teachers that teach science at the middle school level, though the Montana Statewide Education Profile document reports there were 606 full-time equivalent science teachers in 1998-1999 across all grade levels (Nielson, 2001). This same document states that all middle schools will include science in their programs and specifies that Jr. High and students of grades 7-8 are required to take one unit of science annually.

Student populations in these 210 schools range from four 7th-8th students in Peerless, Montana, to 984 students at C.R. Anderson Middle School in Helena, Montana. Enrollment and science teaching assignments can vary from year to year, but based on the 2007-2008 enrollment numbers, it was determined that 303 seventh and eighth grade science teachers comprised the population of teachers that had access to the survey instruments. Because of school size, some participants teach science exclusively while others teach other subjects as well. Mailing addresses for all of the 210 schools solicited for this research were obtained from the Directory of Montana Schools 2007-2008.

A-Priori

In order to determine the sample size needed for adequate sensitivity, an online sample size calculator was used (MaCorr, 2008). At a 95% confidence level with a confidence interval of 6%, it was determined that a sample population of 142 was necessary out of the total population of 303 science teachers. In order to determine the minimum sample size for the predictor variables used in the multiple regression analysis, an online sample size calculator was employed (Soper, 2008). At an alpha level of 0.05, with an effect size of 0.15, and a power level of 0.8, it was determined that with 13 predictor variables the minimum sample size would have to be 131 out of the total population of 303. Decisions regarding statistical significance of the findings were made using an alpha level of 0.05.

Data Collection

To address the research questions of this study, three teacher survey instruments were administered. Self-reported teacher surveys raise red flags with regards to concerns over reliability and validity. While survey results may not be as accurate as researchers would always like, these types of measures do provide a glimpse into the minds of the respondents (Wiersma & Jurs, 2005). Mayer (1999) found a 0.69 correlation between teachers' responses to surveys administered twice in a 4-month period and a 0.85 correlation between his observational data and survey responses.

Each principal of the 210 schools was sent by mail a cover letter, consent form and copies of the questionnaire. The number of copies sent to each school was based on the student enrollment in the middle grades and the estimated number of middle school science teachers that serve the seventh and eighth grade student population. Within the cover letter was a description of the purpose of the study, assurance of anonymity and instructions for dissemination to the teachers. The letter to the administrators, letter to teacher participants, information letter about the study, and survey instructions are presented in Appendices D, E, F and G, respectively. Each principal was to place the questionnaires in teachers' mailboxes and the teachers were to complete the survey at their convenience. The researcher's phone number and email address was included in the event that teachers had any questions about the study. Upon completion, each teacher was instructed to place the instruments in the self-addressed envelope and place it in their school building's outgoing mail. Upon receipt by the researcher, the envelope was separated from the data so that there were no identifiers as to where the data came from. To encourage potential participants to complete and mail in the surveys, a drawing was held for those who participated with the lucky winner receiving an iPod Nano. This drawing was held four weeks after the initial mailing. The information contained on this postcard is found in Appendix I. Marshall et al. (2007) speculates that the high return rate of their teacher surveys can be partially attributed to teachers' chances of being awarded a gift card through a random drawing. Using incentives to increase response rate has received mixed reviews (Teisl, Roe, & Vayda, 2005) but there is no evidence that there are deleterious effects on the quality of survey responses (Singer, Groves, & Corning, 1999).

A friendly postcard reminder, found in Appendix H, was sent two weeks after the initial mailing to the principals of each of the 210 schools. The principals were kindly asked to pass on the reminder postcard to the appropriate science teachers. The postcard provided directions to obtain additional copies of the survey instruments if necessary. This postcard also offered thanks to those who had already mailed the completed survey.

Instruments

Three different instruments were included in the teacher survey packet consisting of the background and experience questionnaire, the Teaching Science as Inquiry (TSI) instrument and the Attitudes and Beliefs on Classroom Control (ABCC-R) inventory. It was estimated that it would take about 15 minutes to complete the survey packet.

Teachers' Background

Teachers' background and experience addressed age, gender, ethnicity, educational level, major and minor areas of study, teaching endorsement(s), years of teaching experience, years at present science teaching position, grade level(s) taught, hours of preparation time provided per week (prep period), hours of science inquiry professional development and experience working with a scientist and/or in a research environment. These items were chosen based upon their use in similar research and the contradictory findings from these studies. Their selection was also influenced by thorough consultation with experts in the field. The background survey instrument is presented in Appendix A.

Teaching Science as Inquiry (TSI)

The TSI instrument consists of 69 items that measure teachers' self-efficacy in regard to the teaching of science as inquiry (Smolleck et al., 2006). This instrument contains 34 items that address personal self-efficacy and 35 items that address outcome expectancy. For the purpose of this study, only the 34 personal self-efficacy questions were used because outcome expectancy is not relevant to the research questions. Additionally, behaviors are usually better predicted by self-efficacy beliefs than outcome expectations (Schunk & Miller, 2002). The 34 self-efficacy questions are divided among five sections which address the following essential features of classroom inquiry which are aligned with the five essential features recognized by the National Science Education Standards, (NRC, 2000):

1. Learner engages in scientifically oriented questions. (7 items)
2. Learner gives priority to evidence in responding to questions. (8 items)
3. Learner formulates explanations from evidence. (6 items)
4. Learner connects explanations to scientific knowledge. (6 items)
5. Learner communicates and justifies explanations (7 items)

Responses to the questions use a 5-point scale with *5 = Strongly Agree, 4 = Agree, 3 = Uncertain, 2 = Disagree, and 1 = Strongly Disagree.* Responses to the survey items were summed to obtain a score for each participant. This score was divided by the number of items on the survey to obtain a mean score that reflects the level of self-efficacy toward teaching science as inquiry.

A 13-step process was used to develop and build validity and reliability into the TSI instrument (Smolleck et al., 2006). The construct was defined based upon the five essential features of the National Science Education Standards (NCR, 2000). Items were constructed and the first version of the test questions was judged for content validity by faculty members and graduate students from the University of Florida, Pennsylvania State University and the University of Missouri. As items were revised, they were presented to panels of experts. After reviewing comments, the instrument was revised again by the researchers. Six versions of the TSI items were reviewed by professionals who are experts in the field of science inquiry. Content validity can be established by asking experts if the items assess what they claim to assess (Salkind, 2006). The seventh version was administered in a study with 190 preservice elementary teachers. Analysis of the collected data was examined for construct validity and the contributions each item made to the reliability of the instrument. The strongest items were identified though item score to total test correlation and items contribution to total test reliability. To measure internal consistency, coefficient alpha revealed reliability of this instrument. The ranges on internal consistency for self-efficacy were from 0.6884 to 0.7244.

The eighth and final TSI version was completed and administered to 184 of the same set of teachers. Data from Version 8 was examined for evidence of construct validity by item score to total test score correlation and item contribution to total test reliability. The strongest items were identified and retained. The ranges on internal consistency for self-efficacy were from 0.6579 to 0.7566. These results met or exceeded the requirements for internal consistency (Sax, 1974; Nunnally, 1978, as cited in Smolleck et al., 2006). Based on the 13-step process and analysis of the data, the TSI authors concluded that the TSI instrument exhibited high to moderate internal reliability, high to moderate test-retest reliability and appears to be a content and construct valid instrument for measuring self-efficacy in regards to teaching science as inquiry. Permission to use this instrument in the present study was granted by Dr. Lori D. Smolleck. The TSI instrument is presented in Appendix B.

Attitudes and Beliefs on Classroom Control-Revised (ABCC-R)

The Attitudes and Beliefs on Classroom Control-R (ABCC-R) inventory is an instrument developed to measure various aspects of teachers' perceptions and predispositions toward their classroom control practices. Responses to the 20-item ABCC-R survey fall under four categories with *4 = Describes me well, 3 = Describes me usually, 2 = Describes me somewhat, and 1 = Describes me not at all*. The ABCC-R is divided into two different construct subscales: instructional management (10 items) and people management (10 items). Instructional management refers to how teachers conduct components of instruction such as independent practice work, dissemination of materials and administration of assessments. The manner in which teachers interact with students that enables students to function and develop within the classroom environment makes up the people management dimension. Each of the two dimensions was developed to provide a continuum of teacher control ranging from high control to low control. Scoring for items 1, 3, 7, 9, 10, 12, 13, 14, 16, and 20 are reversed in order to prevent a set pattern of responses. Responses to the survey items were summed to obtain a score for each participant. This score was divided by the number of items on the survey to obtain a mean score that reflects the participants' attitudes and beliefs toward classroom control. Participants scoring above the mean were identified as more controlling than those who scored below the mean who were considered as less controlling.

Prior to the ABCC-R inventory, Martin, Yin, and Baldwin (1998) developed the Attitudes and Beliefs of Classroom Control (ABCC) inventory to measure teachers' perceptions of their approaches to classroom control. This inventory consisted of 48-items with three dimensions: Instructional Management (24 items), People Management (9 items) and Behavior Management (15 items). To determine the reliability and validity of the instrument, selected sub-scales of the 16 Personality Factor Questionnaire (16PF) Form A were used to describe the personality traits that connected to characteristics of teachers' behaviors in a classroom setting. Of the 16 dimensions of personality in the 16PF, six were included in the validation of the ABCC based on previous research (Martin & Baldwin, 1993). An exploratory factor analysis was used to identify items with eigenvalues greater than 1.00 and a minimum loading of 0.35 for subsequent tests of reliability. Six factors met the criteria. Scree plots were examined and the first three factors were retained. Additional analysis using a varimax rotation identified those items that were placed into the dimensions that corresponded with three proposed classroom control dimensions. Using the same criteria as used in the first factor analysis, 26 items were retained: Instructional Management (14 items), People Management (8 items), and Behavior Management (4 items).

Cronbach alpha coefficients were used to verify internal consistency as a measurement of reliability. To meet the minimum standard of reliability for scales in the developmental stages, alpha coefficients had to be at 0.60 or above. Alpha coefficients for instructional management, people management and behavior management were 0.82, 0.69 and 0.69, respectively. In order to identify the contribution of each item to internal consistency, an item analysis was performed. Only items with an adjusted item-total correlation coefficient of 0.20 or above were accepted and considered to be statistically significant towards contributing to the validity of the scale.

Concurrent validity was determined using Pearson product moment correlations that were acquired between the scores on the 16PF subscales and the three factors retained from the scree plot. Five of the six subscales of the 16PF produced significant correlations with the ABCC subscales supporting concurrent validity of this instrument.

In order to refine its ability to measure the construct of classroom management, the ABCC instrument was revised and emerged as the Attitudes and Beliefs of Classroom Control – Revised (ABCC-R) (Martin et al., 2007). To refine the original ABCC, a factor loading of 0.40 was used as the cut-off for the consideration of an item as a salient factor. Because 0.70 is considered to be the minimum acceptable internal consistency coefficient (Cronbach, as cited in Martin et al., 2007), only items at or above 0.70 were retained. As with the original ABCC instrument, a minimum of 0.20 for item-total correlation coefficients were accepted as being contributors to the validity of the ABCC-R instrument. The behavior management dimension from the original ABCC instrument was removed because of its validity and reliability weakness. What resulted was the ABCC-R instrument that consists of 10 instructional management items and 10 people management items. Martin et al. (2007) claims that the trimming of the ABCC to the ABCC-R was a considerable refinement of the ability of this instrument to measure the construct of attitudes and beliefs on classroom control. Permission to use this instrument in the present study was granted by Dr. Nancy K. Martin. The ABCC instrument is presented in Appendix C.

Statistical Procedures

Data collected from the surveys was analyzed using the 17.0 SPSS computer software program. Descriptive statistics included measures of central tendency, dispersion, and frequency distributions to address demographic data as it relates to the personal and professional attributes of the participants and their classroom control styles and their efficacy towards teaching science as inquiry. Inferential statistics included between group comparisons with t-tests and ANOVAS, Pearson product moment correlational analysis, and an ordinary least squares (OLS) linear multiple regression procedure. All statistical procedures are summarized in Figure 2. Decisions regarding statistical significance of the findings were made using an alpha level of 0.05 except the correlation analysis which used an alpha of 0.01. Results from the Pearson product moment correlation indicated the direction for which teachers with higher self-efficacy for teaching science as inquiry had in relation to their attitudes and beliefs toward classroom control as well any relationship between the instructional management (IM) and people management (PM) scores from the ABCC-R instrument.

Multiple regression analysis is used in research to examine the relationship between independent variables and a dependent variable. In a linear multiple regression, computer analysis determines the order in which independent variables affect the regression equation (Huck, 2000). In the multiple linear regression analysis in this study, the predictor variables listed in Table 2 were used to explain the variance in the criterion variables. Those predictor variables that emerged as statistically significant, less than 0.05, were identified as predictors of (1) self-efficacy toward teaching science as inquiry and (2) attitudes and beliefs toward classroom control. The OLS regression was chosen for this study because of its effectiveness and efficient use of data, especially with relatively small data sets (NIST/SEMATECH, 2008).

Summary

This chapter presented the methodology for the collection and analysis of the data used to address the research questions. The discussion of the research design described the population and sample, a-priori assumptions, the manner in which data was collected, and the three survey instruments. Features of the Teacher Background survey, the Teaching Science as Inquiry (TSI) instrument and Attitudes and Beliefs on Classroom Control-Revised (ABCC-R) instrument were presented including how reliability and validity for these instruments were established. The statistical procedures used to analyze the data were explained and appear in Table 2.

Table 2

Statistical Analysis Summary

Research Questions/Hypotheses	Variables	Statistical Analysis
1. What specific areas of 7th and 8th grade science teachers' background predict teachers' efficacy toward teaching science as inquiry? H_1: 7th and 8th science teachers' efficacy towards teaching science as inquiry will be statistically higher for those teachers with greater teaching background and than those teachers with less science teaching background.	Dependent Variable - Teacher Efficacy toward Teaching Science as Inquiry Predicator Variables - Age - Gender - Ethnicity - Highest Educational Level - Major Areas of Study - Minor Areas of Study - Years of Teaching - Years at Present Position - Grade Levels Taught - Teaching Endorsement(s) - Prep Time/Week - Inquiry PD Experience - Experience w/ Inquiry Research	T-tests and ANOVA for between group comparisons Ordinary least squares (OLS) linear regression analysis were used to determine which of the background variables can be used to predict the level of personal self-efficacy in regards to teaching science as inquiry.
2. What specific areas of 7th and 8th grade science teachers' background predict teachers' attitudes and beliefs toward control? H_2: 7th and 8th grade science teachers' attitudes and beliefs towards classroom control will be statistically higher for those teacher with greater science teaching background and experience than those teachers with less science teaching background and experience.	Dependent Variable - Teacher Attitudes and Beliefs toward Classroom Control Predicator Variables - Age - Gender - Ethnicity - Highest Educational Level - Major Areas of Study - Minor Areas of Study - Years of Teaching - Years at Present Position - Grade Levels Taught - Teaching Endorsement(s) - Prep Time/Week - Inquiry PD Experience - Experience w/ Inquiry Research	T-tests and ANOVA for between group comparisons Ordinary least squares (OLS) linear regression analysis were used to determine which of the background and experience variables can be used to predict the level of attitudes and beliefs in regards to classroom control.
3. What is the relationship between 7th and 8th grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs toward classroom control? H_3: 7th and 8th grade science teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs towards classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry .	- Teacher Self-efficacy towards Teaching Science as Inquiry - Classroom Control Styles - Instructional Management - People Management	Pearson product moment correlation analysis was used to determine the strength and direction of the relationship between teacher's efficacy toward teaching science as inquiry and their attitudes and beliefs towards classroom control.

CHAPTER 4 – FINDINGS

Introduction

This chapter presents the results of the descriptive and inferential analysis used to describe the sample population and address the research questions and hypotheses designed for this study. Information is presented in three sections. The first section contains frequency distributions and measures of central tendency and dispersion to describe the sample. In the second section, the dependent scaled variables are described using descriptive statistics. The final section uses inferential statistics to address the three research questions and related hypotheses.

The purpose of this study was to examine middle school science teachers' background and the relationships this has with teacher self-efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control as well as the relationship between teacher self-efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control. This study further examined if teacher background variables were predictors of teacher self-efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control.

To collect the data that was analyzed, survey packets containing the Teacher Background, Attitudes and Beliefs of Classroom Control-Revised, and Teaching Science as Inquiry instruments were sent to the 210 schools in Montana that teach seventh and eight grade science. Of the 303 packets which represent the number of seventh and eighth science teachers, 132 were returned for a response rate of 44%. This fell short of the 142 specified as a-priori which resulted in a confidence interval of 6.4% instead of the target of 6%. This response rate may have been affected by the fact that the packets were mailed to school administrators who then made the decision whether or not to pass them on to their science teaching staff. While the teachers were informed that their responses were confidential, the personal nature of the questions and the probing into their beliefs about their teaching may have discouraged some from participating. The 132 responses did meet the a-priori definition with regards to satisfying a power level of 0.8 with the 13 predictor variables in the linear multiple regression analyses.

Description of the Sample

The Teacher Background survey asked information about the following variables: age, gender, ethnicity, highest educational level, major area(s) of study, minor areas(s) of study, teaching endorsements, years of teaching experience, years in present science teaching position, grade levels taught, hours of preparation time provided per week, hours of science inquiry professional development and experience working with a research scientist or in a research environment. Responses were summarized using descriptive statistics and are found in Tables 3-16.

The frequency distribution of the age of the participants is reported in Table 3.

Table 3

Descriptive Statistics
Age of Participants (n=132)

Dimension	Average Age	SD	Range	
			Minimum	Maximum
Male	44.85	11.00	24	64
Female	40.10	11.43	23	63
Overall	42.44	11.43	23	64

Teachers' ages ranged from 23 to 64 with a mean age of 42.44 (SD=11.43) for the sample population. The mean age for males was 44.85 (SD=11.00) and for females 40.10 (SD=11.43).

The frequency distribution of participants' gender is presented in Table 4.

Table 4

Frequency Distribution
Gender of Participants (n=132)

Gender	Frequency	Percent
Male	65	49.24%
Female	67	50.76%

A nearly 1:1 ratio of male science teachers to female science teachers was revealed. Male teachers comprised 49.24% (n=65) of the sample population and females represented 50.76% (n=67).

Teachers were asked to report their ethnicity and their responses were summarized using descriptive statistics and are found in Table 5.

Table 5

Frequency Distribution
Ethnicity of Participants (n=132)

Ethnicity	Frequency	Percent
African-American	0	0.00%
Caucasian	131	99.24%
Hispanic	0	0.00%
Native American	0	0.00%
Other	1	0.76%

All but one of the 132 participants reported their ethnicity as Caucasian. The one respondent who was not Caucasian was of an ethnicity not identified in the survey.

Participants indicated their highest educational degree attained and those results were summarized using frequency distributions and are presented in Table 6.

Table 6

Frequency Distributions
Highest Educational Degree Attained (n=132)

Degree	Frequency	Male	Female	Percent
Bachelor's	70	31	39	53.03%
Master's	60	33	27	45.45%
Ed. Specialist	1	0	1	0.76%
Doctorate	1	1	0	0.76%
Other	0	0	0	0.00%

Only two participants reported their highest level of education as being something other than a bachelor's or master's degree. Of these two, one had a doctorate and the other reported an educational specialist credential. A bachelor's degree as the highest level of education attained was reported by 53.03% of the respondents with 45.45% having a master's degree. More males had a master's degrees (n=33) than females (n=27). Consequently, because of the near equal gender ratio, more females had only bachelor degrees (n=39) than males (n=31).

Teacher participants were asked to report their major and minor areas of study. This data was summarized using frequency distributions and appears in Table 7.

Table 7

Frequency Distributions
Major and Minor Areas of Study (n=132)

Major	Frequency	Percent
Science	72	54.55%
Education	74	56.06%
Other	17	12.88%
Minor	Frequency	Percent
Science	39	29.55%
Education	25	18.94%
Other	37	28.03%

Even though n=132 for the sample population, the total number of cases for each of the major and minor areas of study does not equal 132 because some teachers reported more than one major and/or more than one minor area of study. The distribution of science majors to education majors was nearly equal, n=72 (54.55%) and n=74 (56.06%), respectively. Seventeen participants (12.88%) had majors that were not in the areas of science or mathematics.

The distribution of minors in science versus minors in education revealed 39 science minors (29.55%) and 25 (18.94%) education minors. Thirty-seven teachers (28.03%) reported minor areas of study that did fall under the science or education label.

To gather an idea of what kind of teaching endorsement(s) these teachers possessed, participants chose from a list of 10 possibilities. Their responses were summarized using frequency distributions and appear in Table 8.

Table 8

Frequency Distributions
Teaching Endorsements (n=132)

Teaching Endorsement	Frequency	Percent
Provisional	1	0.76%
Elementary K-8	44	33.33%
Broadfield Science	61	46.21%
Biology	45	34.09%
Chemistry	23	17.42%
Biological Science	16	12.12%
Earth Science	15	11.36%
Physical Science	9	6.82%
Physics	4	3.03%
Other	29	21.97%

Because several teachers possessed more than one teaching endorsement, the total number of endorsements indicated exceeds the sample population of 132. Only one teacher was teaching with a provisional endorsement. Forty-four of the participants (33.33%) had Elementary K-8 teaching endorsements. Of the science-related endorsements, 61 (46.21%) were Broadfield Science, 45 (34.09%) were Biology, 23 (17.42%) were Chemistry, 16 (12.12%) were Biological Science, 15 (11.36%) were Earth Science, nine (6.82%) were Physical Science (6.82%) and four (3.03%) were in Physics. Of the sample population, 29 (21.97%) endorsements fell under the “Other” category.

Teachers were asked to indicate the number of years they had been teaching. Their years of teaching experience and how this was broken down with regards to gender, highest level of education attained, and participants’ major area of study was analyzed. These responses were summarized using descriptive statistics and are presented in Table 9.

Table 9

Descriptive Statistics
Years of Teaching Experience (n=132)

Dimension	Average Years of Experience	SD	Range	
			Minimum	Maximum
Male	15.50	10.56	1	41
Female	13.28	9.79	1	40
Bachelor’s	11.14	9.18	1	40
Master’s	17.88	10.16	1	41
Ed. Specialist	15.00	N/A	15	15
Doctorate	30.00	N/A	30	30
Education Major	14.63	10.30	1	36
Science Major	14.44	9.72	1	41
Other Major	16.76	10.96	3	40
Overall	14.38	10.20	1	41

The average number of years of teaching experience among the respondents was 15.50 SD=10.56) for males and 13.28 (SD=9.79) for females. The ranges of years teaching experience for males and females was 40 and 39, respectively. Teachers whose highest level of education attained was a bachelor’s degree averaged 11.14 (SD=9.18) years of teaching experience and those with a master’s degree averaged 17.88 (SD=10.16) years as a teacher. The single education specialist and the single teacher with a doctorate had 15.00 and 30.00 years of teaching experience, respectively. The average number of years taught by teachers who majored in science in college was14.44 (SD=9.72) years and for education majors it was 16.76 (SD=10.30). Teachers who indicated other majors had 16.76 (SD=10.96) years of teaching experience. Overall, the average number of years taught by the sample population was 14.38 (SD=10.20).

Teachers were asked to indicate how many years they had taught in their present teaching position. Their responses were divided into gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 10.

Table 10

Descriptive Statistics
Years in Present Science Teaching Position (n=132)

Dimension	Average Years At Current	SD	Range	
			Minimum	Maximum
Male	10.06	9.81	1	41
Female	6.45	5.92	1	25
Bachelor's	6.71	7.00	1	29
Master's	9.75	9.12	1	41
Ed. Specialist	5.00	N/A	5	5
Doctorate	26.00	N/A	26	26
Education Major	7.18	6.95	1	32
Science Major	9.78	9.00	1	41
Other Major	7.94	8.40	1	25
Overall	8.23	8.25	1	41

The average number of years of teaching at the current teaching position among the respondents was 10.06 (SD=9.81) for males and 6.45 (SD=5.92) for females. The ranges of years at these positions for males and females were 40 and 24, respectively. Teachers whose highest level of education attained was a bachelor's degree averaged 6.71 (SD=7.00) years of teaching at the current position while those with a master's degree averaged 9.75 (SD=9.12) years. The single education specialist and the single teacher with a doctorate had 5.00 and 26.00 years of teaching experience in their current position, respectively. The average number of years taught by teachers in their respective positions who majored in science in college was 9.78 (SD=9.00) years and for education majors it was 7.18 (SD=6.95). Teachers who indicated other majors had 7.94 (SD=8.40) years of teaching experience where they are teaching now. Overall, the average number of years taught in their present teaching position by the sample population was 8.23 (SD=8.25).

While the present study targeted seventh and eighth grade science teachers, many of these teachers taught at other grade levels as well. This data was summarized using frequency distributions and appears in Table 11.

Table 11

Frequency Distributions
Grade Levels Taught (n=132)

Grade Levels Taught	Frequency	Percent
6th Grade and Below	57	43.18%
7th Grade	111	84.09%
8th Grade	114	86.36%
9th Grade and Above	54	40.91%

The total number of cases exceeds132 because many teachers taught at more than one grade level of science. The number of respondents who taught science at the 6th grade level and below was 57, at the 7th grade level 111, at the 8th grade level 114, and at the 9th grade level or above 54.

Teachers were asked to indicate how many weekly hours of contracted preparation time they were allowed in their present teaching position. Their responses were divided into gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 12.

Table 12

Descriptive Statistics
Average Weekly Hours of Preparation Time in
Present Science Teaching Position (n=132)

Dimension	Average Hours of Preparation Time	SD	Range	
			Minimum	Maximum
Male	5.04	1.80	0	10
Female	5.59	4.88	1	40
Bachelor’s	5.47	4.54	1	40
Master’s	5.24	2.39	0.8	15
Ed. Specialist	5.00	N/A	5	5
Doctorate	0.00	N/A	0	0
Education Major	5.16	2.39	0	15
Science Major	5.49	4.58	0.8	40
Other Major	5.75	1.99	4	10
Overall	5.32	3.7	0	40

The average number of weekly hours of contracted preparation time at the current teaching position among the respondents was 5.04 (SD=1.80) for males and 5.59 (SD=4.88) for females. The ranges of preparation time for males and females were 10 hours and 39, respectively. Teachers whose highest level of education attained was a bachelor’s degree averaged 5.47 (SD=4.54) hours of preparation time at the current position while those with a master’s degree averaged 5.24 (SD=2.39) hours. The single education specialist and the single teacher with a doctorate had 5.00 and 0.00 hours of preparation time in their current position, respectively. The average number of hours of preparation time of teachers in their respective positions who majored in science in college was 5.49 (SD=4.58) hours and for education majors it was 5.16 (SD=2.39). Teachers who indicated other majors had 5.75 (SD=1.99) hours of weekly preparation time where they are teaching now. Overall, the average number hours of preparation time per week by the sample population was 5.32 (SD=3.70).

Participants were asked to indicate whether or not they had ever experienced professional development with regards to teaching science as inquiry. Their responses were divided into gender, highest level of education attained, and participants' major area of study. This data was summarized using frequency distributions and appears in Table 13.

Table 13

Frequency Distributions
Professional Development Experience in
Teaching Science as Inquiry (n=132)

Dimension	Total Cases	Had Science Inquiry PD	Percent
Male	65	33	50.77%
Female	67	32	47.76%
Bachelor's	70	26	37.14%
Master's	60	38	63.33%
Ed. Specialist	1	0	0.00%
Doctorate	1	1	100.00%
Education Major	74	41	55.41%
Science Major	72	34	47.22%
Other Major	17	6	35.29%
Overall	132	65	49.24%

Professional development experience in teaching science as inquiry was reported by 33 (50.77%) of the male teachers (n=65) and 32 (47.76%) of the female teachers (n=67). With regards to the highest level of education attained, of those with bachelor's degrees (n=70), 26 (37.14%) had inquiry professional development and of those with master's degrees (n=60), 38 (63.33%) had this type of experience. The single education specialist had not had inquiry professional development whereas the single teacher with a doctorate had. With regards to majors, 41 (55.41%) with an education major (n=74), 34 (47.22%) with a science major (n=72), and 17 (35.29%) who indicated their major as other, had professional development in teaching science as inquiry. Of the total cases (n=132), 65 (49.24%) had professional development experience in science inquiry.

To find out the extent of participants' experience with science inquiry professional development, respondents were asked to indicate how many hours of inquiry professional development they had received. Their responses were divided into gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 14.

Table 14

Descriptive Statistics

Average Hours of Professional Development Experience in Teaching Science as Inquiry for all Participants (n=132)

Dimension	Average Hours of Science Inquiry PD	SD	Range	
			Minimum	Maximum
Male	16.63	34.87	0	160
Female	18.24	47.02	0	320
Bachelor's	8.87	19.59	0	100
Master's	27.37	56.08	0	320
Ed. Specialist	0.00	N/A	0	0
Doctorate	40.00	N/A	40	40
Education Major	22.07	50.69	0	320
Science Major	15.03	32.26	0	160
Other Major	10.53	36.09	0	150
Overall	17.45	41.34	0	320

The results presented in Table 13 include all participants (n=132). The average hours of science inquiry professional development for males was 16.63 (SD=34.87) with a range of 0 to 160 and for females the average hours was 18.24 (SD=47.02) with a range of 0 to 320 hours. Those with a bachelor's degree averaged 8.87 hours (SD=19.59) with a range of 0 to 100 hours whereas those with a master's degree averaged 27.37 hours

(SD=56.08) with a range of 0 to 320 hours. The education specialist had no hours of science inquiry professional development and the teacher with a doctorate had received 40 hours of training. Education majors had an average of 22.07 hours (SD=50.69) with a range of 0 to 320 hours, science majors had an average of 15.03 hours (SD=32.26) with a range of 0 to 160 hours, and those with other majors had an average of 10.53 hours (SD=36.09) with a range of 0 to 150 hours. The overall hours of science inquiry professional development for the sample population was 17.45 (SD=41.34) for a range of 0 to 320 hours.

To examine further the hours of experience with professional development in teaching science as inquiry, data from only those with inquiry professional development was analyzed. Responses were divided into gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 15.

Table 15

Descriptive Statistics

Average Hours of Professional Development Experience in
Teaching Science as Inquiry for only Participants with Inquiry Experience (n=65)

Dimension	Frequency	Average Hours of Science Inquiry PD	SD	Range	
				Minimum	Maximum
Male	33	32.76	43.45	1	160
Female	32	38.19	62.62	2	320
Bachelor's	26	23.88	26.18	3	100
Master's	38	43.21	65.66	1	320
Ed. Specialist	0	N/A	N/A	N/A	N/A
Doctorate	1	40.00	N/A	40	40
Education	41	39.83	62.96	1	320
Science Major	34	31.82	41.09	2	160
Other Major	6	29.83	58.97	2	150
Overall	65	35.43	53.39	1	320

Of the teachers who had received professional development in teaching science as inquiry, the 33 males averaged 32.76 hours (SD=43.45) with a range of 1 to 160 hours and females averaged 38.19 (SD=62.62) with a range of 2 to 320 hours. Those with a bachelor's degree (n=26) averaged 23.88 hours (SD=26.18) with a range of three to 100 hours whereas those with a master's degree (n=38) averaged 43.21 hours (SD=65.66) with a range of one to 320 hours. The teacher with a doctorate had received 40 hours of training. Education majors (n=41) had an average of 39.83 hours (SD=62.96) with a range of one to 320 hours, science majors (n=34) had an average of 31.82 hours (SD=41.09) with a range of two to 160 hours, and those with other majors (n=6) had an average of 29.83 hours (SD=58.97) with a range of two to 150 hours. The overall hours of science inquiry professional development for those in the sample population who had training (n=65) was 35.43 (SD=53.39) for a range of one to 320 hours.

Participants were asked to indicate whether or not they had experience working with a research scientist or in a research environment. Responses were divided into gender, highest level of education attained, and participants' major area of study. These responses were summarized using frequency distributions and appear in Table 16.

Table 16

Frequency Distributions
Experience in Science Research (n=132)

Dimension	Total Cases	Experience in Science Research	Percent
Male	65	25	38.46%
Female	67	15	22.39%
Bachelor’s	70	18	25.71%
Master’s	60	21	35.00%
Ed. Specialist	1	0	0.00%
Doctorate	1	1	100.00%
Education Major	74	21	28.38%
Science Major	72	30	41.67%
Other Major	17	2	11.76%
Overall	132	40	30.30%

Of the sample population who had experience working with a research scientist or in a research environment, 25 (38.46%) of the males (n=65) and 15 (22.39%) of the females (n=67) indicated this. Regarding the highest level of education attained, 18 (25.71%) of the 70 with bachelor’s degrees and 21 (35.00%) of the 60 with master’s degrees had this experience. The single education specialist had no research experience whereas the teacher with a doctorate had. Regarding major areas of study in college, 21 (28.38%) of the education majors (n=74), 30 (41.67%) of the science majors (n=72), and 2 (11.76%) of the other majors (n=17) indicated research science experience. In all, 40 (30.30%) of the 132 participants had experience working with a research scientist or in a science research environment.

Description of the Scaled Variables

Each of the participants’ mean scores were summarized using descriptive statistics in order to provide baseline data for the self-efficacy scale of TSI instrument and the instructional management (IM) and people management (PM) subscales of the ABCC-R instrument. Frequency distributions for the TSI and ABCC-R instruments were analyzed in terms of participants' mean scores occurring above and below the sample population mean.

Teachers' responses to the Teaching Science as Inquiry (TSI) survey were analyzed according to gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 17.

Table 17

Descriptive Statistics
Average Teaching Science as Inquiry (TSI) Scores (n=132)

Dimension	Average TSI Score	SD	Range	
			Minimum	Maximum
Male	4.10	0.44	2.71	5.00
Female	4.07	0.48	3.00	5.00
Bachelor's	3.98	0.46	2.71	5.00
Master's	4.19	0.42	3.38	5.00
Ed. Specialist	4.50	N/A	4.50	4.50
Doctorate	4.82	N/A	4.82	4.82
Education Major	4.09	0.43	2.71	5.00
Science Major	4.14	0.47	3.00	5.00
Other Major	4.01	0.43	3.18	4.82
Overall	4.08	0.46	2.71	5.00

The TSI instrument consisted of 34 questions that addressed teachers' personal self-efficacy toward teaching science as inquiry. Responses to the questions used a 5-point scale with *5 = Strongly Agree, 4 = Agree, 3 = Uncertain, 2 = Disagree, and 1 = Strongly Disagree.* The average TSI score for the 65 male participants was 4.10 (SD=0.44) with a range of 2.71 to 5.00 and for the 67 female participants the TSI average score was 4.07 (SD=0.48) with a range of 3.00 to 5.00. The mean TSI score according to the highest level of education attained was 3.98 (SD=0.46) and a range of 2.71 to 5.00 for those with bachelor's degrees, 4.19 (SD=0.42) and a range of 3.38 to 5.00 for teachers with master's degrees, 4.50 for the single education specialist, and 4.82 for the teacher with a doctorate degree.

Education majors had an average TSI score of 4.09 (SD=0.43) with a range of 2.71 to 5.00, science majors' mean score was 4.14 (SD=0.47) with a range of 3.00 to 5.00, and those with other majors had a mean score of 4.01 (SD=0.43) with a range of 3.18 to 4.82. The overall TSI mean score for the sample population was 4.08 (SD=0.46) with a range of 2.71 to 5.00.

The ABCC-R instrument contains 20 items addressing teachers' beliefs in the categories of Instructional Management (10 items) and People Management (10 items). Teachers' responses to the Instructional Management questions of the ABCC-R survey were analyzed according to gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 18.

Table 18

Descriptive Statistics
Average Instructional Management (IM) Scores ABCC-R (n=132)

Dimension	Average IM Score	SD	Range	
			Minimum	Maximum
Male	2.93	0.47	1.70	3.80
Female	2.78	0.39	1.60	3.70
Bachelor's	2.89	0.41	1.80	3.80
Master's	2.81	0.47	1.60	3.80
Ed. Specialist	3.20	N/A	3.20	3.20
Doctorate	3.10	N/A	3.10	3.10
Education Major	2.81	0.47	1.60	3.80
Science Major	2.87	0.43	1.60	3.80
Other Major	2.90	0.32	2.20	3.40
Overall	2.85	0.44	1.60	3.80

Ten survey items on the ABCC-R inventory address teachers' beliefs regarding instructional management. Teachers rated each of the items using a one- to four-point Likert-type scale. The average IM score for the 65 male participants was 2.93 (SD=0.47) with a range of 1.70 to 3.80 and for the 67 female participants this was 2.78 (SD=0.39) with a range of 1.60 to 3.70. The mean IM scores according to the highest level of education attained were 2.89 (SD=0.41) and a range of 1.80 to 3.80 for those with bachelor's degrees, 2.81 (SD=0.47) and a range of 1.60 to 3.80 for teachers with master's degrees, 3.20 for the single education specialist, and 3.10 for the teacher with a doctorate degree.

Education majors had an average IM score of 3.20 (SD=0.47) with a range of 1.60 to 3.80, science majors mean score was 2.87 (SD=0.43) with a range of 1.60 to 3.80, and those with other majors had a mean score of 2.90 (SD=0.43) with a range of 2.20 to 3.40. The overall IM mean score for the sample population was 2.85 (SD=0.44) with a range of 1.60 to 3.80.

Teachers' responses to the People Management questions of the ABCC-R survey were analyzed according to gender, highest level of education attained, and participants' major area of study. These responses were summarized using descriptive statistics and appear in Table 19.

Table 19

Descriptive Statistics
Average People Management (PM) Scores ABCC-R (n=132)

Dimension	Average PM Score	SD	Range	
			Minimum	Maximum
Male	2.45	0.41	1.40	3.50
Female	2.47	0.38	1.60	3.40
Bachelor's	2.45	0.40	1.40	3.40
Master's	2.49	0.39	1.60	3.50
Ed. Specialist	2.40	N/A	2.40	2.40
Doctorate	1.90	N/A	1.90	1.90
Education Major	2.42	0.38	1.50	3.50
Science Major	2.49	0.41	1.40	3.40
Other Major	2.48	0.32	2.10	3.00
Overall	2.46	0.39	1.40	3.50

Ten survey items on the ABCC-R inventory address teachers' beliefs regarding people management. Teachers rated each of the items using a one- to four-point Likert-type scale. The average PM score for the 65 male participants was 2.45 (SD=0.41) with a range of 1.40 to 3.50 and for the 67 female participants this was 2.47 (SD=0.38) with a range of 1.60 to 3.40. The mean PM scores according to the highest level of education attained were 2.45 (SD=0.40) and a range of 1.40 to 3.40 for those with bachelor's degrees, 2.49 (SD=0.39) and a range of 1.60 to 3.50 for teachers with master's degrees, 2.40 for the single education specialist, and 1.90 for the teacher with a doctorate degree.

Education majors had an average PM score of 2.42 (SD=0.38) with a range of 1.50 to 3.50, science majors mean score was 2.49 (SD=0.41) with a range of 1.40 to 3.40, and those with other majors had a mean score of 2.48 (SD=0.32) with a range of 2.10 to 3.00. The overall PM mean score for the sample population was 2.46 (SD=0.39) with a range of 1.40 to 3.50.

From the TSI instrument, scores above and below the sample mean were analyzed according to gender, highest level of education attained, and participants' major area of study. This data was summarized using frequency distributions and appears in Table 20.

Table 20
Frequency Distributions
Teaching Science as Inquiry (TSI) Scores
Above and Below Sample Mean (n=132)

Dimension	Cases	TSI 4.08 or Higher	TSI 4.079 or Lower	% Above	% Below
Male	65	30	35	46.15%	53.85%
Female	67	31	36	46.27%	53.73%
Bachelor's	70	26	44	37.14%	62.86%
Master's	60	33	27	55.00%	45.00%
Ed. Specialist	1	1	0	100.00%	0.00%
Doctorate	1	1	0	100.00%	0.00%
Education Major	74	33	41	44.59%	55.41%
Science Major	72	39	33	54.17%	45.83%
Other Major	17	6	11	35.29%	64.71%
Overall	132	61	71	46.21%	53.79%

Of the 65 male participants, 30 (46.15%) had TSI scores of 4.08 or higher and 35 (53.85%) had TSI scores that were 4.079 or lower. Of the 67 female participants, 31 (46.27%) had TSI scores that were 4.08 or greater and 36 (53.73%) had TSI scores of 4.079 or less. Results of analysis based on highest level of education attained found 26 (37.14%) of the 70 participants with bachelor's degrees with a TSI score greater than 4.08 and 44 (62.86%) with TSI scores less than 4.079, and 33 (55.00%) of the 60 participants with master's degrees with a TSI score greater than 4.08 and 27 (45.00%) with TSI scores less than 4.079. Both the single education specialist and doctorate participants had TSI scores greater than 4.08.

With regards to college major, 33 (44.59%) of the 74 education majors had TSI scores above 4.08 and 41 (55.41%) had TSI scores below 4.079; 39 (54.17%) of the 72 science majors had TSI scores above 4.08 and 33 (45.83%) had TSI scores below 4.079; and of the 17 with another major, 6 (35.29%) had a TSI score above 4.08 and 11 (64.71%) had TSI scores below 4.079. Several of the participants declared more than one college major. Of the 132 participants, 61 (46.21%) had TSI scores above 4.08 and 71 (53.79%) had TSI scores below 4.079. Teachers' TSI scores above the sample mean were indicative of higher personal efficacy toward teaching science as inquiry as opposed to those below the mean.

From the ABCC-R instructional management (IM) subscale, scores above and below the sample mean were analyzed according to gender, highest level of education attained, and participants' major area of study. This data was summarized using frequency distributions and appears in Table 21.

Table 21

Frequency Distributions

Average Instructional Management (IM) ABCC-R Scores
Above and Below Sample Mean (n=132)

Dimension	Cases	IM 2.85 or Higher	IM 2.849 or Lower	% Above	% Below
Male	65	39	26	60.00%	40.00%
Female	67	29	38	43.28%	56.72%
Bachelor's	70	37	33	52.86%	47.14%
Master's	60	29	31	48.33%	51.67%
Ed. Specialist	1	1	0	100.00%	0.00%
Doctorate	1	1	0	100.00%	0.00%
Education Major	74	34	40	45.95%	54.05%
Science Major	72	39	33	54.17%	45.83%
Other Major	17	9	8	52.94%	47.06%
Overall	132	68	64	51.52%	48.48%

Of the 65 male participants, 39 (60.00%) had IM scores of 2.85 or higher and 26 (40.00%) had IM scores that were 2.849 or lower. Of the 67 female participants, 29 (43.28%) had IM scores that were 2.85 or greater and 38 (56.72%) had IM scores of 2.849 or less. Results of analysis based on highest level of education attained found 37 (52.86%) of the 70 participants with bachelor's degrees with an IM score greater than 2.85 and 33 (47.14%) with IM scores less than 2.849, and 29 (48.33%) of the 60 participants with master's degrees with an IM score greater than 2.85 and 31 (51.67%) with IM scores less than 2.849. Both the single education specialist and doctorate participants had IM scores greater than 2.85.

With regards to college major, 34 (45.95%) of the 74 education majors had IM scores above 2.85 and 40 (54.05%) had IM scores below 2.849; 39 (54.17%) of the 72 science majors had IM scores above 2.85 and 33 (45.83%) had IM scores below 2.849; and of the 17 with an other major, 9 (52.94%) had an IM score above 2.85 and 8 (47.06%) had IM scores below 2.849. Several of the participants declared more than one college major. Of the 132 participants, 68 (51.52%) had IM scores above 2.85 and 64 (48.48%) had IM scores below 2.849. Teachers with IM scores above the sample mean were categorized as more controlling with regards to instructional management attitudes and beliefs toward classroom control than those with scores below the mean.

From the ABCC-R people management (PM) subscale, scores above and below the sample mean were analyzed according to gender, highest level of education attained, and participants' major area of study. This data was summarized using frequency distributions and appears in Table 22.

Table 22

Frequency Distributions
Average People Management (PM) ABCC-R Scores
Above and Below Sample Mean (n=132)

Dimension	Cases	PM 2.46 or Higher	IM 2.459 or Lower	% Above	% Below
Male	65	32	33	49.23%	50.77%
Female	67	31	36	46.27%	53.73%
Bachelor’s	70	31	39	44.29%	55.71%
Master’s	60	32	28	53.33%	46.67%
Ed. Specialist	1	0	1	0.00%	100.00%
Doctorate	1	0	1	0.00%	100.00%
Education Major	74	33	41	44.59%	55.41%
Science Major	72	38	34	52.78%	47.22%
Other Major	17	7	10	41.18%	58.82%
Overall	132	63	69	47.73%	52.27%

Of the 65 male participants, 32 (49.23%) had PM scores of 2.46 or higher and 33 (50.77%) had PM scores that were 2.459 or lower. Of the 67 female participants, 31 (46.27%) had PM scores that were 2.46 or greater and 36 (53.73%) had PM scores of 2.459 or less. Results of analysis based on highest level of education attained found 31 (44.29%) of the 70 participants with bachelor’s degrees with a PM score greater than 2.46 and 39 (55.71%) with PM scores less than 2.459, and 32 (53.33%) of the 60 participants with master’s degrees with a PM score greater than 2.46 and 28 (46.67%) with PM scores less than 2.459. Both the single education specialist and doctorate participants had PM scores greater than 2.46.

With regards to college major, 33 (44.59%) of the 74 education majors had PM scores above 2.46 and 41 (55.41%) had PM scores below 2.459; 38 (52.78%) of the 72 science majors had PM scores above 2.46 and 34 (47.22%) had PM scores below 2.459; and of the 17 with another major, 7 (41.18%) had a PM score above 2.46 and 10 (58.82%) had

PM scores below 2.459. Several of the participants declared more than one college major. Of the 132 participants, 63 (47.73%) had PM scores above 2.46 and 69 (52.27%) had PM scores below 2.459. Teachers with PM scores above the sample mean were categorized as more controlling with regards to people management attitudes and beliefs toward classroom control than those with scores below the mean.

Research Questions and Hypotheses

Three research questions were developed and investigated in this study. Inferential statistics were employed in order to address each question. Research Questions 1 and 2 are addressed together using independent samples t-tests, one-way analysis of variance (ANOVA) tests and an ordinary least squares (OLS) linear regression. The t-tests and one-way ANOVA analyses examined equality in terms of the instructional management (IM) and people management (PM) subscales of the ABCC-R instrument as well as the TSI instrument with the following independent variables: age, gender, bachelors/masters, science/non-science college major degree, science/non-science college minor, teaching endorsement, years of teaching experience, years at present teaching position, grade levels taught, hours of preparation time/week, science inquiry professional development experience, and science research experience. Because all participants but one indicated an ethnicity of Caucasian, this variable was not analyzed with inferential statistics. Each t-test and ANOVA is presented with a sub-null hypothesis in order to address the hypotheses of Questions 1 and 2. Research Question 3 is analyzed with a Pearson product moment correlation. Decisions on statistical significance were made a-priori using a criterion alpha level of .05 except the correlation analysis which was 0.01.

Between Group Comparisons

Research Questions 1 and 2

Research Question 1: What specific areas of 7^{th} and 8^{th} grade science teachers' background predict teachers' efficacy toward teaching science as inquiry?

Hypothesis 1: 7^{th} and 8^{th} grade science teachers' efficacy towards teaching science as inquiry will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

Research Question 2: What specific areas of 7^{th} and 8^{th} grade science teachers' background predict teachers' attitudes and beliefs toward classroom control?

Hypothesis 2: 7^{th} and 8^{th} grade science teachers' attitudes and beliefs towards classroom control will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

The frequency distribution of participants' age was examined in order to determine the groups for the one-way ANOVA analysis. Three groups emerged and included ages 20-35, 36-50 and over 51. Data descriptives are presented in Table 23. The one-way ANOVA analysis of the TSI, IM and PM scores among age groups is presented in Table 24.

Age as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal among age groups
H_a: At least one age group differs in mean score for TSI, IM, and PM than the others

Table 23

Age Descriptives

	Age	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
TSI Avg.	20 - 35	45	4.0569	0.45884	0.06840	3.9190	4.1947	2.71	5.00
	36-50	48	4.1275	0.44391	0.06407	3.9986	4.2564	3.18	5.00
	Over 51	39	4.0618	0.48726	0.07802	3.9039	4.2198	3.00	4.88
	Total	132	4.0840	0.45976	0.04002	4.0048	4.1632	2.71	5.00
IM Avg.	20 - 35	45	2.8178	0.44225	0.06593	2.6849	2.9506	1.80	3.80
	36-50	48	2.8167	0.48830	0.07048	2.6749	2.9585	1.60	3.80
	Over 51	39	2.9385	0.35734	0.05722	2.8226	3.0543	2.20	3.60
	Total	132	2.8530	0.43745	0.03808	2.7777	2.9284	1.60	3.80
PM Avg.	20 - 35	45	2.3800	0.40261	0.06002	2.2590	2.5010	1.50	3.40
	36-50	48	2.5229	0.43381	0.06261	2.3970	2.6489	1.40	3.50
	Over 51	39	2.4846	0.31080	0.04977	2.3839	2.5854	1.90	3.10
	Total	132	2.4629	0.39218	0.03413	2.3954	2.5304	1.40	3.50

Table 24

Age of Participants ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSI Avg.	Between Groups	0.143	2	0.071	0.335	0.716
	Within Groups	27.548	129	0.214		
	Total	27.691	131			
IM Avg.	Between Groups	0.404	2	0.202	1.057	0.351
	Within Groups	24.665	129	0.191		
	Total	25.069	131			
PM Avg.	Between Groups	0.501	2	0.250	1.643	0.197
	Within Groups	19.648	129	0.152		
	Total	20.148	131			

From the analysis results, it was determined to fail to reject the null and conclude no difference among age groups for the TSI ($p=0.716$), IM ($p=0.351$) and PM ($p=0.197$)

scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores at the different age levels.

The mean TSI, IM and PM scores were analyzed in terms of gender for statistical significance. The independent samples t-test for gender is presented in Table 25.

Gender as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal for men and women
H_a: The mean score for TSI, IM, and PM is not equal for men and women

Table 25

Participants' Gender
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	2.389	0.125	0.359	130	0.720	0.02884	0.08031	-0.13004	0.18773
Equal variances not assumed			0.360	129.616	0.720	0.02884	0.08021	-0.12984	0.18753
IM Ave. Equal variances assumed	3.521	0.063	1.952	130	0.053	0.14710	0.07536	-0.00199	0.29618
Equal variances not assumed			1.946	123.744	0.054	0.14710	0.07558	-0.00250	0.29669
PM Ave. Equal variances assumed	0.054	0.816	-0.260	130	0.795	-0.01780	0.06852	-0.15336	0.11777
Equal variances not assumed			-0.259	128.259	0.796	-0.01780	0.06861	-0.15355	0.11796

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. From the analysis results, it was determined to fail to reject the null and conclude no equality among participants' gender for the TSI (p=0.720), IM (p=0.053) and PM (p=0.795) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to participants' gender.

The mean TSI, IM and PM score were analyzed in terms of bachelor's versus master's degrees for statistical significance. Since there was only one education specialist and one doctorate, these were excluded from the highest degree attained analysis. Group statistics for the bachelor/masters degrees are presented in Table 26 and the independent samples t-test for the bachelor's/master's degrees is presented in Table 27.

Highest Degree Attained as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal for people with bachelor's and master's degrees
H_a: The mean score for TSI, IM, and PM is not equal for people with bachelor's and master's degrees

Table 26

Participants' Highest Degree Attained: Bachelor's and Master's
Group Statistics

	Degree Recode	N	Mean	Std. Deviation	Std. Error Mean
TSI Avg.	Bachelor's	70	3.9782	0.46471	0.05554
	Master's	60	4.1882	0.42453	0.05481
IM Avg.	Bachelor's	70	2.8857	0.41224	0.04927
	Master's	60	2.8050	0.46847	0.06048
PM Avg.	Bachelor's	70	2.4471	0.39954	0.04775
	Master's	60	2.4917	0.38501	0.04970

Table 27

Participants' Highest Degree Attained: Bachelor's and Master's Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.079	0.779	2.674	128	0.008	-0.21008	0.07858	-0.36557	-0.05460
Equal variances not assumed			-2.692	127.426	0.008	-0.21008	0.07803	-0.36449	-0.05568
IM Ave. Equal variances assumed	0.398	0.529	1.045	128	0.298	0.08071	0.07724	-0.07213	0.23355
Equal variances not assumed			1.035	118.625	0.303	0.08071	0.07801	-0.07376	0.23519
PM Ave. Equal variances assumed	0.368	0.545	-0.644	128	0.521	-0.04452	0.06913	-0.18130	0.09225
Equal variances not assumed			-0.646	126.227	0.519	-0.04452	0.06893	-0.18093	0.09188

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. Because of low sample size, the single education specialist and doctorate degrees were excluded from analysis. The null was rejected and concluded no equality with the TSI (p=0.008). For the IM (p=0.298) and PM (p=0.521) scores, the null failed to be rejected and equality was concluded. Therefore, participants with master's degrees had significantly higher scores with regards to self-efficacy towards teaching science as inquiry than those participants whose highest degree attained were bachelor's degrees. There was no statistical difference in the population means of the IM and PM scores with regards to participants' self-efficacy towards teaching science as inquiry.

Data was analyzed using an independent samples t-test to examine TSI, IM and PM scores in terms whether participants had a science or non-science college major. Results of this analysis are presented in Table 28.

College Major as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal for teachers who have a science major and those who have a different major
H_a: The mean score for TSI, IM, and PM is not equal for teachers who have a science major and those who have a different major

Table 28

Participants' College Major: Science and Non-Science
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.189	0.665	-1.476	130	0.142	-0.11806	0.08001	-0.27634	0.04023
Equal variances not assumed			-1.482	127.513	0.141	-0.11806	0.07968	-0.27573	-0.03962
IM Ave. Equal variances assumed	0.365	0.547	-0.551	130	0.583	-0.04222	0.07667	-0.19391	0.10946
Equal variances not assumed			-0.549	124.629	0.584	0.04222	0.07684	-0.19430	0.10986
PM Ave. Equal variances assumed	0.874	0.352	-0.923	130	0.358	-0.06333	-0.06859	-0.19903	0.07237
Equal variances not assumed			-0.934	129.492	0.352	-0.06333	0.06784	-0.19755	0.07088

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. From the analysis results, it was determined to fail to reject the null and conclude no difference among participants' science versus non-science majors for the TSI (p=0.142), IM (p=0.583) and PM (p=0.358) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to whether participants had a science major or other major in college.

Data was analyzed using an independent samples t-test to examine TSI, IM and PM scores in terms whether participants had a science or non-science college minor. Results of this analysis are presented in Table 29.

College Minor as an Independent Variable

Ho: The mean score for TSI, IM, and PM is equal for teachers who had a science minor and those who did not
Ha: The mean score for TSI, IM, and PM is not equal for teachers who had a science minor and those who did not

Table 29

Participants' College Minor: Science and Non-Science
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.003	0.959	0.005	130	0.996	0.00041	0.08805	-0.17377	0.17460
Equal variances not assumed			0.005	71.774	0.996	0.00041	0.087882	-0.17466	0.17549
IM Ave. Equal variances assumed	1.789	0.183	-0.449	130	0.654	-0.03755	0.08371	-0.20316	0.12806
Equal variances not assumed			-0.484	85.106	0.630	-0.03755	0.07765	-0.19193	0.11683
PM Ave. Equal variances assumed	0.092	0.763	-1.341	130	0.182	-0.10000	0.07459	-0.24757	0.04757
Equal variances not assumed			-1.401	78.965	0.165	-0.10000	0.07137	-0.24206	0.04206

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. From the analysis results, it was determined to fail to reject the null and conclude no difference among participants' science versus non-science minors for the TSI (p=0.996), IM (p=0.654) and PM (p=0.182) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to whether participants had a science major or other minor in college.

Data descriptives of the TSI, IM and PM scores among the groups' teaching endorsement in terms of science only, education only, and both science and education is presented in Table 30. The one-way ANOVA analyses of these groups' scores are presented in Table 31.

Teaching Endorsement as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal among teaching endorsement groups
H_a: At least one teaching endorsement group differs in mean score for TSI, IM, and PM than the others

Table 30

Teaching Endorsement Groups
Group Statistics

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
TSI Avg.	Science Endorsement Only	64	4.0924	0.46713	0.05839	3.9757	4.2091	3.00	5.00
	Education Endorsement Only	39	4.1154	0.42151	0.06750	3.9787	4.2520	3.29	5.00
	Both Science and Education Endorsement	29	4.0233	0.50150	0.09313	3.8326	4.2141	2.71	4.88
	Total	132	4.0840	0.45976	0.04002	4.0048	4.1632	2.71	5.00
IM Avg.	Science Endorsement Only	64	2.8797	0.42768	0.05346	2.7729	2.9865	1.60	3.70
	Education Endorsement Only	39	2.8154	0.50343	0.08061	2.6522	2.9786	1.70	3.80
	Both Science and Education Endorsement	29	2.8448	0.36896	0.06851	2.7045	2.9852	2.30	3.60
	Total	132	2.8530	0.43745	0.03808	2.7777	2.9284	1.60	3.80
PM Avg.	Science Endorsement Only	64	2.4094	0.37827	0.04728	2.3149	2.5039	1.40	3.20
	Education Endorsement Only	39	2.4718	0.39132	0.06266	2.3449	2.5986	1.50	3.20
	Both Science and Education Endorsement	29	2.5690	0.41413	0.07690	2.4114	2.7265	1.90	3.50
	Total	132	2.4629	0.39218	0.03413	2.3954	2.5304	1.40	3.50

Table 31

Teaching Endorsement Groups ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSI Avg.	Between Groups	0.150	2	0.075	0.350	0.705
	Within Groups	27.541	129	0.213		
	Total	27.691	131			
IM Avg.	Between Groups	0.103	2	0.051	0.265	0.767
	Within Groups	24.966	129	.194		
	Total	25.069	131			
PM Avg.	Between Groups	0.513	2	0.256	1.684	0.190
	Within Groups	19.635	129	0.152		
	Total	20.148	131			

From the analysis results, it was determined to fail to reject the null and conclude no difference among participant groups' according to teaching endorsements for the TSI (p=0.705), IM (p=0.767) and PM (p=0.190) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to teaching endorsement based on science only, education only or both science and education.

The frequency distribution of participants' years of teaching was examined in order to determine the groups for the one-way ANOVA analysis. Three groups emerged and included the following three blocks: one to seven years, 8 to 19 years, and over 20 years of teaching experience. Data descriptives are presented in Table 32. The one-way ANOVA analysis of the TSI, IM and PM scores among the groups' years of teaching experience is presented in Table 33.

Years of Teaching Experience as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal among blocks of years taught
H_a: At least one block of years taught differs in mean score for TSI, IM, and PM than the others

Table 32

Years of Teaching Experience Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
TSI Avg.	1 to 7 Years	44	3.9993	0.46493	0.07009	3.8580	4.1407	2.71	5.00
	8 to 19 Years	49	4.1182	0.43436	0.06205	3.9935	4.2430	3.21	5.00
	Over 20 Years	39	4.1365	0.48284	0.07732	3.9800	4.2930	3.06	5.00
	Total	132	4.0840	0.45976	0.04002	4.0048	4.1632	2.71	5.00
IM Avg.	1 to 7 Years	44	2.8614	0.41608	0.06273	2.7349	2.9879	1.80	3.80
	8 to 19 Years	49	2.7592	0.47210	0.06744	2.6236	2.8948	1.60	3.60
	Over 20 Years	39	2.9615	0.39843	0.06380	2.8324	3.0907	2.30	3.80
	Total	132	2.8530	0.43745	0.03808	2.7777	2.9284	1.60	3.80
PM Avg.	1 to 7 Years	44	2.3523	0.43642	0.06579	2.2196	2.4850	1.40	3.40
	8 to 19 Years	49	2.4939	0.35905	0.05129	2.3907	2.5970	1.60	3.10
	Over 20 Years	39	2.5487	0.35900	0.05749	2.4323	2.6651	1.90	3.50
	Total	132	2.4629	0.39218	0.03413	2.3954	2.5304	1.40	3.50

Table 33

Years of Teaching Experience ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSI Avg.	Between Groups	0.480	2	0.240	1.139	0.323
	Within Groups	27.210	129	0.211		
	Total	27.691	131			
IM Avg.	Between Groups	0.894	2	0.447	2.385	0.096
	Within Groups	24.175	129	.187		
	Total	25.069	131			
PM Avg.	Between Groups	0.873	2	0.436	2.920	0.057
	Within Groups	19.275	129	0.149		
	Total	20.148	131			

From the analysis results, it was determined to fail to reject the null and conclude no difference among participant groups' years of teaching experience for the TSI ($p=0.323$), IM ($p=0.096$) and PM ($p=0.057$) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to the different levels of years of teaching experience.

The frequency distribution of participants' years of teaching at their present teaching position was examined in order to determine the groups for the one-way ANOVA analysis. Three groups emerged and included the following three blocks: one to three years, 4 to 10 years, and over 20 years of teaching experience. Data descriptives are presented in Table 34. The one-way ANOVA analysis of the TSI, IM and PM scores among the groups' years of teaching experience is presented in Table 35.

Years of Teaching Experience at Present Position as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal among years in present position
H_a: At least one age group differs in mean score for TSI, IM, and PM than the others

Table 34

Years of Teaching Experience at Present Position Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
TSI Avg.	1 To 3 Years	53	4.0444	0.49406	0.06786	3.9082	4.1806	2.71	5.00
	4 To 10 Years	44	4.0822	0.41982	0.06329	3.9546	4.2099	3.21	4.88
	Over 10 Years	35	4.1462	0.46017	0.07778	3.9881	4.3043	3.06	5.00
	Total	132	4.0840	0.45976	0.04002	4.0048	4.1632	2.71	5.00
IM Avg.	1 To 3 Years	53	2.8981	0.43699	0.06002	2.7777	3.0186	1.80	3.80
	4 To 10 Years	44	2.7955	0.41031	0.06186	2.6707	2.9202	1.80	3.60
	Over 10 Years	35	2.8571	0.47421	0.08016	2.6942	3.0200	1.60	3.60
	Total	132	2.8530	0.43745	0.03808	2.7777	2.9284	1.60	3.80
PM Avg.	1 To 3 Years	53	2.4094	0.40490	0.05562	2.2978	2.5210	1.40	3.40
	4 To 10 Years	44	2.4977	0.38549	0.05811	2.3805	2.6149	1.80	3.50
	Over 10 Years	35	2.5000	0.38271	0.06469	2.3685	2.6315	1.60	3.10
	Total	132	2.4629	0.39218	0.03413	2.3954	2.5304	1.40	3.50

Table 35

Years of Teaching Experience at Present Position ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSI Avg.	Between Groups	0.254	2	0.127	0.661	0.518
	Within Groups	24.815	129	0.192		
	Total	25.069	131			
IM Avg.	Between Groups	0.253	2	0.127	0.820	0.443
	Within Groups	19.895	129	0.154		
	Total	20.148	131			
PM Avg.	Between Groups	0.219	2	0.109	0.514	0.600
	Within Groups	27.472	129	0.213		
	Total	27.691	131			

From the analysis results, it was determined to fail to reject the null and conclude no difference among participant groups' years of teaching experience at their present teaching position for the TSI (p=0.518), IM (p=0.443) and PM (p=0.600) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to the different levels of years of teaching experience at the present teaching position.

Data was analyzed based on grade levels taught and grouped according teachers who taught 7th grade and below only, 8th grade and above only, and 7th & 8th grade and above. Data descriptives are presented in Table 36 and the one-way ANOVA analysis of the TSI, IM and PM scores among the three groups of grade levels taught is presented in Table 37.

Grade Levels Taught as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal among grade levels taught
H_a: At least one grade level group differs in mean score for TSI, IM, and PM than the others

Table 36

Grade Levels Taught Descriptives

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
TSI Avg.	7th Grade & Below Only	15	4.1176	0.37203	0.09606	3.9116	4.3237	3.65	4.88
	8th Grade & Above Only	19	4.0588	0.46401	0.10645	3.8352	4.2825	3.38	5.00
	7th & 8th Grade & Above	98	4.0837	0.47460	0.04794	3.9886	4.1789	2.71	5.00
	Total	132	4.0840	0.45976	0.04002	4.0048	4.1632	2.71	5.00
IM Avg.	7th Grade & Below Only	15	2.9333	0.39400	0.10173	2.7151	3.1515	2.00	3.60
	8th Grade & Above Only	19	2.8053	0.44155	0.10130	2.5924	3.0181	2.00	3.60
	7th & 8th Grade & Above	98	2.8500	0.44542	0.04499	2.7607	2.9393	1.60	3.80
	Total	132	2.8530	0.43745	0.03808	2.7777	2.9284	1.60	3.80
PM Avg.	7th Grade & Below Only	15	2.5800	0.42795	0.11050	2.3430	2.8170	1.90	3.20
	8th Grade & Above Only	19	2.5579	0.28346	0.06503	2.4213	2.6945	2.00	3.10
	7th & 8th Grade & Above	98	2.4265	0.40143	0.04055	2.3460	2.5070	1.40	3.50
	Total	132	2.4629	0.39218	0.03413	2.3954	2.5304	1.40	3.50

Table 37

Grade Levels Taught ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSI Avg.	Between Groups	0.029	2	0.015	0.068	0.935
	Within Groups	27.662	129	0.214		
	Total	27.691	131			
IM Avg.	Between Groups	0.141	2	0.070	0.365	0.695
	Within Groups	24.928	129	0.193		
	Total	25.069	131			
PM Avg.	Between Groups	0.507	2	0.253	1.664	0.193
	Within Groups	19.641	129	0.152		
	Total	20.148	131			

From the analysis results, it was determined to fail to reject the null and conclude no difference among participant groups' according to grade levels taught for the TSI (p=0.935), IM (p=0.695) and PM (p=0.193) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to the different grade levels taught.

The mean TSI, IM and PM score were analyzed for statistical significance in regards to participants' hours of preparation time per week. The independent samples t-test for hours of preparation time per week is presented in Table 38.

Preparation Time as Independent Variable

H_o: The mean score for TSI, IM, and PM is equal for teachers who had less than five hours of prep time/week than those who had five hours or more
H_a: The mean score for TSI, IM, and PM is not equal for teachers who had less than five hours of prep time/week than those who had five hours or more

Table 38

Participants' Preparation Hours per Week
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.269	0.605	1.253	130	0.212	0.10276	0.08201	-0.05948	0.26500
Equal variances not assumed			1.269	110.826	0.207	0.10276	0.08097	-0.05769	0.26321
IM Ave. Equal variances assumed	6.385	0.013	0.202	130	0.840	0.01583	0.07848	-0.13944	0.17110
Equal variances not assumed			0.217	127.856	0.828	0.01583	0.07286	-0.12834	0.16000
PM Ave. Equal variances assumed	0.122	0.727	-1.098	130	0.274	-0.07691	0.07005	-0.21549	0.06168
Equal variances not assumed			-1.108	109.739	0.270	-0.07691	0.06938	-0.21441	0.06060

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. From the analysis results, it was determined to fail to reject the null and conclude no difference among participants' hours of preparation time week for the TSI (p=0.212), IM (p=0.828) and PM (p=0.274) scores. Therefore, there is no statistical difference in the population means of the TSI, IM and PM scores with regards to how many hours of preparation time per week the participants had.

The mean TSI, IM and PM score were analyzed for statistical significance in regards to whether or not participants had training or professional development in science inquiry. Group statistics for science inquiry experience appears in Table 39 and the independent samples t-test for science inquiry experience is presented in Table 40.

H_o: The mean score for TSI, IM, and PM is equal for teachers who had science inquiry and those who did not
H_a: The mean score for TSI, IM, and PM is not equal for teachers who had science inquiry and those who did not

Table 39

Participants' Professional Development Experience in Science Inquiry
Group Statistics

	Science Inquiry Experience	N	Mean	Std. Deviation	Std. Error Mean
TSI Avg.	No	67	3.9478	0.47292	0.05778
	Yes	65	4.2244	0.40319	0.05001
IM Avg.	No	67	2.8343	0.44536	0.05441
	Yes	65	2.8723	0.43175	0.05355
PM Avg.	No	67	2.4791	0.37438	0.04574
	Yes	65	2.4462	0.41196	0.05110

Table 40

Participants' Professional Development Experience in Science Inquiry
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.195	0.660	-3.612	130	0.000	-0.27667	0.07660	-0.42821	-0.12513
Equal variances not assumed			-3.621	127.905	0.000	-0.27667	0.07641	-0.42787	-0.12547
IM Ave. Equal variances assumed	0.053	0.818	-0.497	130	0.620	-0.03798	0.07638	-0.18909	0.11313
Equal variances not assumed			-0.497	130.00	0.620	-0.03798	0.07634	-0.18901	0.11306
PM Ave. Equal variances assumed	0.652	0.421	0.481	130	0.631	0.03295	0.06848	-0.10253	0.16843
Equal variances not assumed			0.480	127.976	0.632	0.03295	0.06858	-0.10274	0.16864

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. For the TSI (p=0.000) the null is rejected and it is concluded that there exists a true difference. Failure to reject the null and conclude equality resulted from both the IM (p=0.620) and PM (p=0.631) analyses. Therefore, participants with science inquiry professional development experience scored significantly higher with regards to self-efficacy towards teaching science as inquiry

(TSI) than those without this experience. There is no statistical difference in the population means of the IM and PM scores with regards to whether participants had science inquiry professional development experience or not.

The mean TSI, IM and PM score were analyzed for statistical significance in regards to whether or not participants had experience working with a research scientist or in a research environment. Group statistics for science research experience appears in Table 41 and the independent samples t-test for science research experience is presented in Table 42.

Science Research Experience as an Independent Variable

H_o: The mean score for TSI, IM, and PM is equal for teachers who had research experience and those who did not
H_a: The mean score for TSI, IM, and PM is not equal for teachers who had research experience and those who did not

Table 41

Participants' Science Research Experience
Group Statistics

	Science Research Experience	N	Mean	Std. Deviation	Std. Error Mean
TSI Avg.	No	92	4.0189	0.43585	0.04544
	Yes	40	4.2338	0.48347	0.07644
IM Avg.	No	92	2.8913	0.41315	0.04307
	Yes	40	2.7650	0.48281	0.07634
PM Avg.	No	92	2.5130	0.37158	0.03874
	Yes	40	2.3475	0.41817	0.06612

Table 42

Participants' Science Research Experience
Independent Samples T-Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TSI Ave. Equal variances assumed	0.165	0.685	-2.519	130	0.013	-0.21496	0.08535	-0.38382	-0.04610
Equal variances not assumed			-2.417	67.803	0.018	-0.21496	0.08893	-0.39243	-0.03750
IM Ave. Equal variances assumed	0.833	0.363	1.532	130	0.128	0.12630	0.08243	-0.03677	0.28938
Equal variances not assumed			1.441	64.964	0.154	0.12630	0.08765	-0.04875	0.30136
PM Ave. Equal variances assumed	1.160	0.283	2.264	130	0.025	0.16554	0.07313	0.02086	0.31023
Equal variances not assumed			2.160	66.990	0.034	0.16554	0.07663	0.01259	0.31850

Based on Levene's test of equality of variance, there is failure to reject the null hypothesis of equal variances for all three variables, and thus it is appropriate to assume equal variances for the t-test. For both the TSI (p=0.013) and the PM (p=0.025) the null is rejected and it is concluded that there exists a true difference. Failure to reject the null and conclude equality resulted from the IM analysis (p=0.128). Therefore, participants with science research experience scored significantly higher with regards to self-efficacy towards teaching science as inquiry (TSI) than those without this experience. Teachers who indicated that they had been involved in science research listed such as experiences as working in summer labs and internships at universities, undergraduate assistants in college research laboratories, and research within careers prior to becoming teachers. Teachers who had no science research experience had significantly higher people management (PM) scores than those teachers who have had science research experience. There is no statistical difference in the population means of the IM scores with regards to whether participants had science research experience or not.

Regression Analyses

Research Question 1

In order to address Research Question 1 which concerns specific areas of 7th and 8th grade science teachers' background that predict teachers' self-efficacy toward teaching science as inquiry, an ordinary least squares (OLS) linear regression was performed. The dependent variable was the TSI average scores and the predictor variables were gender, masters degree, science major, science minor, years of teaching experience, years of teaching experience at the present position, preparation time, science inquiry professional development experience, science research experience, science teaching endorsement, 7th grade level and under teachers, and 8th grade level and above teachers. The dichotomous variables were all coded 0 as "no" and 1 as "yes", except for gender which 0 is male and 1 is female. The regression model summary appears in Table 43, the ANOVA (b) analysis is in Table 44 and regression coefficients are presented in Table 45.

Table 43

TSI Regression Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.429(a)	0.184	0.102	0.43579

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience

Table 44

TSI ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.090	12	0.424	2.234	0.014(a)
	Residual	22.600	119	0.190		
	Total	27.691	131			

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience
b Dependent Variable: PM Avg.

Table 45

TSI Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	3.821	0.214		17.882	0.000
	Gender	0.015	0.081	0.017	0.190	0.850
	Masters	0.099	0.084	0.107	1.174	0.243
	Science Major	0.216	0.108	0.234	2.000	0.048
	Science Minor	-0.043	0.087	-0.043	-0.489	0.626
	Yrs. Experience	0.003	0.005	0.066	0.550	0.583
	Yrs. Present Position	-0.004	0.007	-0.079	-0.653	0.515
	Prep. Time	-0.015	0.011	-0.123	-1.426	0.157
	Science Inquiry	0.206	0.081	0.225	2.548	0.012
	Research Experience	0.179	0.092	0.180	1.952	0.053
	Science Endorsement	-0.161	0.114	-0.160	-1.404	0.163
	7th Grade and Under	0.093	0.115	0.071	0.808	0.421
	8th Grade and Above	0.065	0.127	0.045	0.516	0.606

a Dependent Variable: TSI Avg.

The ANOVA for the TSI scores' regression produced a significance level of 0.014 indicating that the model is significant. Two predictor variables, Science Major (t=2.000, p=0.048) and Science Inquiry Experience (t=2.548, p=0.012), entered the regression equation accounting for 10.2% (Adjusted R^2 =0.102) of the variation in self-efficacy toward teaching science as inquiry F= 2.234, p=0.014. This indicates that teachers with a major in science were more likely to have a greater self-efficacy toward teaching science as inquiry than teachers who did not have a major in science and that teachers with science inquiry professional development experience were more likely to have a greater self-efficacy toward teaching science as inquiry than teachers who did not have any science inquiry professional development experience. The remaining teacher background variables were not significant predictors of teachers' self-efficacy toward teaching science as inquiry.

Based on the statistically significant findings for self-efficacy toward teaching science as inquiry, the null hypothesis for Research Question 1 is rejected. Teachers with a major in science who have had science inquiry professional development experience were more likely to have a greater self-efficacy toward teaching science as inquiry.

Research Question 2

In order to address Research Question 2 which concerns specific areas of 7th and 8th grade science teachers' background that predict teachers' attitudes and beliefs on classroom control, two ordinary least squares (OLS) linear regressions were performed. The first regression addressed the instructional management (IM) subscale of the ABCC-R inventory and the second regression analyzed the people management (PM) subscale. The dependent variables of the two regressions were the IM average scores and the PM average scores. The predictor variables were gender, masters degree, science major, science minor, years of teaching experience, years of teaching experience at the present position, preparation time, science inquiry professional development experience, science research experience, science teaching endorsement, 7th grade level and under teachers, and 8th grade level and above teachers. The dichotomous variables were all coded 0 as “no” and 1 as “yes”, except for gender which 0 is male and 1 is female. The IM regression model summary appears in Table 46 and the ANOVA (b) analysis is in Table 47.

Table 46

IM Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.366(a)	0.134	0.047	0.42709

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience

Table 47

IM ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.363	12	0.280	1.536	0.120(a)
	Residual	21.706	119	0.182		
	Total	25.069	131			

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience
b Dependent Variable: IM Avg.

The overall IM regression model is not significant (p=0.120) indicating that with this population there are no variables that can be used as predictors of attitudes and beliefs in terms of the instructional management subscale of the ABCC-R inventory.

The PM regression model summary appears in Table 48, the ANOVA (b) analysis is in Table 49 and regression coefficients are presented in Table 50.

Table 48

PM Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.406(a)	0.165	0.081	0.37595

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience

Table 49

PM ANOVA (b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.329	12	0.277	1.963	0.034(a)
	Residual	16.819	119	0.141		
	Total	20.148	131			

a Predictors: (Constant), 8th Grade and Above, Prep. Time, Masters, Science Minor, Gender, 7th Grade and Below, Science Inquiry, Yrs. Present Position, Science Endorsement, Research Experience, Science Major, Yrs. Experience
b Dependent Variable: PM Avg.

Table 50
PM Coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	2.518	0.184		13.660	0.000
	Gender	-0.018	0.070	-0.023	-0.255	0.799
	Masters	0.024	0.072	0.031	0.337	0.737
	Science Major	0.110	0.093	0.141	1.187	0.238
	Science Minor	0.142	0.075	0.166	1.882	0.062
	Yrs. Experience	0.008	0.005	0.204	1.668	0.098
	Yrs. Present Position	-0.005	0.006	-0.102	-0.841	0.402
	Prep. Time	0.022	0.009	0.207	2.367	0.020
	Science Inquiry	-0.007	0.070	-0.009	-0.104	0.918
	Research Experience	-0.257	0.079	-0.303	-3.251	0.001
	Science Endorsement	-0.056	0.099	-0.066	-0.572	0.568
	7th Grade and Under	-0.097	0.099	-0.087	-0.983	0.327
	8th Grade and Above	-0.162	0.109	-0.132	-1.485	0.140

a Dependent Variable: PM Avg.

The ANOVA for the PM scores' regression produced a significance level of 0.034 indicating that the model is significant. Two predictor variables, Prep Time (t= 2.367, p=0.020) and Science Research Experience (t=-3.251, p=0.001), entered the regression equation accounting for 8.1% (Adjusted R^2 =0.081) of the variation in self-efficacy toward teaching science as inquiry F=1.963, p=0.034. Because hours of preparation time per week were examined as a continuous variable and the coefficient was positive, teachers with more hours of prep time are more controlling with regards to their attitudes and beliefs toward classroom control than teachers with less hours of prep time. This regression also indicates that teachers with science research experience were more likely to be less controlling with regards to their attitudes and beliefs on classroom control than teachers without research experience. The remaining teacher background variables were not significant predictors of teachers' attitudes and beliefs on classroom control.

Based on the statistically significant findings for teachers' attitudes and beliefs on classroom control, the null hypothesis for Research Question 2 is rejected. Teachers with science research experience who have fewer hours of preparation time per week are more likely to exert less control over their classroom.

Correlational Analysis

Research Question 3

In order to determine the relationship between participants' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control, a Pearson product moment correlation analysis was conducted.

> *Research Question 3:* What is the relationship between 7th and 8th grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control?
>
> *Hypothesis 3:* 7th and 8th grade science teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs on classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry.

Prior to running the correlation analysis, testing for normality was performed. The results of the Kolmogorov-Smirnov (a) and Shapiro-Wilk tests of normality are presented in Table 51.

Table 51

Correlation Analysis Normality Test – TSI, IM and PM

	Kolmogorov-Smirnov(a)			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
TSI Avg.	0.087	132	0.015	0.984	132	0.117
IM Ave.	0.078	132	0.045	0.982	132	0.083
PM Avg.	0.086	132	0.017	0.989	132	0.365

a Lilliefors Significance Correction

Based on the Shapiro-Wilk test of normality, the null was rejected for all three variables and it was concluded that the data is normal. Due to normality, the Pearson product moment correlation analysis was conducted. Results of this analysis are presented in Table 52.

Table 52

Pearson Product Moment Correlation Analysis – TSI, IM and PM

		TSI Avg.	IM Avg.	PM Avg.
TSI Avg.	Pearson Correlation	1	0.065	-0.069
	Sig. (2-tailed)		0.462	0.429
	N	132	132	132
IM Avg.	Pearson Correlation	0.065	1	0.381(**)
	Sig. (2-tailed)	0.462		0.000
	N	132	132	132
PM Avg.	Pearson Correlation	-0.069	0.381(**)	1
	Sig. (2-tailed)	0.429	0.000	
	N	132	132	132

** *Correlation is significant at the 0.01 level (2-tailed).*

The only two variables that showed a significant linear relationship were the IM and PM scores ($r=0.381$, $p<0.01$). Since this is a positive relationship, when one of these variables goes up, the other will as well. There was no significant linear relationship between the IM or PM scores with the TSI scores. In fact, the linear relationship is almost zero indicating essentially no relationship at all. Thus, the hypothesis that teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs on classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry is rejected.

Summary

Results from the survey data analysis was presented in this chapter. Frequency distributions and measures of central tendency and dispersion were used to describe the sample. The dependent scaled variables were described using descriptive statistics. Inferential statistics were employed to address the three research questions and related hypotheses and consisted of between group comparisons using t-tests and ANOVAs, ordinary least squares regression analyses, and a Pearson product moment correlation analysis.

CHAPTER 5 – CONCLUSIONS

Introduction

The discussion presented in this chapter addresses the following five sections: Summary of the study, Findings, Conclusions, Implications, and Future Research. The summary of this study provides an overview of the research project including why this research was performed and how it was conducted. The next section reviews the findings from the statistical analysis of the data. The third segment contains the conclusions drawn from the research experience. The implications presented in the fourth section provide suggestions for addressing the issues that have been raised in the research conducted. The final section presents thoughts regarding those areas of the research that warrant further study.

Summary of the Study

The science education community feels strongly about the promotion and practice of inquiry-based instruction in science classrooms. Within the National Science Education Standards, inquiry is the premiere process that determines what science is taught and how that science is learned. Support for the contention that students learn science better from inquiry-based laboratory activities is well documented and evidenced by students' higher achievement on science concept assessments. In spite of all that appears beneficial with regards to teaching and learning with inquiry, the consensus among science educators is that inquiry is not practiced at the level it should be in the majority of today's science classrooms. This raises the question of why? What are the barriers that are preventing students from engaging in inquiry experiences? Many reasons have been cited and include it's because teachers teach the way they've been taught, it's hard to do, materials are costly, and teachers feel the need to get through the textbook (Anderson, 2002; Crawford, 2007; French, 2005; Marlow & Stevens, 1999). However, it would be remiss for science education researchers to assume that these obstacles are the only ones impeding inquiry-based instruction progress. More stones need to be turned over in order to understand the reasons for the omission of inquiry in science instruction. The intent of this study was to explore additional components of seventh and eighth grade science teachers' instruction and pedagogy that may explain why inquiry is not practiced consistently and to the extent it should be. Teachers teaching seventh and eighth grade sciences tend to have a greater variation in background experience due to the qualifications necessary to teach at these levels.

Teachers' self-efficacy, their attitudes and beliefs about classroom management and control, and the background experience they bring to their classrooms are influences on instructional decisions and practices. Self-efficacy is the belief one has about his or her ability towards successfully performing a given task. Because self-efficacy is context specific, a teacher might have highly efficacious in one area of their instruction but have a low efficacy in another. For example, a teacher may feel confident about his or her ability to assess student learning, but lack confidence towards teaching science as inquiry. Classroom management and control enter into the equation because science inquiry activities involve greater classroom control skills by the instructor as opposed to teacher-lead, direct instruction. Therefore, a teacher's attitudes and beliefs toward classroom control might influence whether or not inquiry is promoted and performed. Self-efficacy and classroom control procedures can be greatly shaped by teachers' background and experience. While teachers may begin their careers armed with knowledge and experience from their role as a student and from teacher preparation programs, teachers evolve as they teach, learning what works and what doesn't. In spite of the many common and consistent pedagogical practices associated with high quality teaching, teachers are individuals. But before examining teachers' reluctance or inability to conduct inquiry-based instruction on a case-by-case basis, it is first worthy to consider the possibilities of common barriers that reach across groups of science teachers and their associated relationships that have yet to be investigated thoroughly.

This study utilized a non-experimental correlation design to examine middle school science teachers' background and the relationships this has with teacher self-efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control. Because science inquiry activities involve greater classroom control skills by the instructor as opposed to teacher-led, direct instruction, the relationship between teacher efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control framed the research questions for this study. This study asks the following research questions with their associated research hypotheses:

Research Question 1. What specific areas of 7^{th} and 8^{th} grade science teachers' background predict teachers' efficacy toward teaching science as inquiry?

Research Question 2. What specific areas of 7^{th} and 8^{th} grade science teachers' background predict teachers' attitudes and beliefs on classroom control?

Research Question 3. What is the relationship between 7^{th} and 8^{th} grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control?

Hypothesis 1: 7th and 8th grade science teachers' efficacy towards teaching science as inquiry will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

Hypothesis 2: 7th and 8th grade science teachers' attitudes and beliefs on classroom control will be statistically higher for those teachers with greater science teaching background than those teachers with less science teaching background.

Hypothesis 3: 7th and 8th grade science teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs on classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry.

To address the research questions of this study, three teacher survey instruments were administered. The target population was all of the 7th and 8th grade science teachers in that state of Montana. Of the 210 schools that offer science at this level, 303 survey packets were mailed to the schools' principals who were asked to then pass the surveys on to their teachers. Teachers who elected to participate returned the completed surveys anonymously in self-addressed, stamped envelopes. Reminder postcards were sent two weeks after the initial mailing which produced additional responses. Of the 303 packets mailed, 132 were returned for 43.6% response rate. This response rate may have been affected by the fact that the surveys had to first pass through the hands of principals before reaching the science teachers. Evidence of this was obtained when a personal friend of the researcher at a larger middle school claimed that she and her colleagues did not receive the surveys.

The three different instruments in the teacher survey packet included the background questionnaire, the Teaching Science as Inquiry (TSI) instrument and the Attitudes and Beliefs on Classroom Control-Revised (ABCC-R) instrument. The teachers' background survey addressed age, gender, ethnicity, educational level, major and minor areas of study, teaching endorsement(s), years of teaching experience, years at present science teaching position, grade level(s) taught, hours of preparation time provided per week (prep period), hours of science inquiry professional development and experience working with a scientist and/or in a research environment. The 34-question TSI instrument measured teachers' self-efficacy toward teaching science as inquiry with the sample mean being the dividing line between teachers with higher and teachers with lower self-efficacy toward teaching science as inquiry. The 20-question ABCC-R instrument measured teachers' attitudes and beliefs on classroom control in which teachers were grouped according to where they ended up in relation to mean scores from the instructional management (IM) and people management (PM) subscales. Scores higher than the mean indicated a more controlling approach to classroom control whereas scores lower than the mean were indicative of teachers who are less controlling.

Data collected from the surveys was analyzed using the 17.0 SPSS computer software program. Descriptive statistics included measures of central tendency, dispersion, and frequency distributions to address demographic data as it relates to the personal and professional attributes of the participants and their classroom control styles and their self-efficacy towards teaching science as inquiry. The inferential statistics used to address the research questions were independent samples t-tests, ANOVAs, Pearson product moment correlation analysis and an ordinary least squares (OLS) linear multiple regression.

Decisions regarding statistical significance of the findings were made using an alpha level of 0.05 except the correlation analysis which used 0.01.

Findings

Three research questions and associated hypotheses were developed in order to investigate seventh and eighth grade Montana science teachers' background, efficacy toward teaching science as inquiry, and attitude and beliefs on classroom control. Data from three survey instruments, Teacher Background, Teaching Science as Inquiry, and Attitudes and Beliefs on Classroom Control was analyzed using inferential statistics. Statistical significance decisions were made using a criterion alpha level of 0.05 except the correlation analysis which used 0.01.

Of the 303 survey packets mailed to the 210 schools in Montana with seventh and eighth grade science programs, 132 were completed and returned for a 43.6% return rate. Respondents' ages ranged from 24 to 64 with an average age of 42.44. Gender was nearly equal with 65 male teachers and 67 female teachers. All participants indicated their ethnicity as Caucasian except for one participant who chose other. With regards to the highest college degree attained, 70 had master's degrees, 60 had bachelor's degrees, one was an educational specialist and one had a doctorate degree.

Several teachers had more than one college major which accounts for 72 science majors, 74 education majors and 17 other majors. Of those who indicated college minors, 39 were in science, 25 were in education and 37 were others. Many teachers had more than one teaching endorsement and this broke down into the following: provisional (1), elementary K-8 (44), broadfield science (61), physical science (9), biological science (16), physics (4), chemistry (23), biology (45), earth science (15), and other (29).

The average years of teaching experience was 14.38 (SD=10.20) with a range of one to 41 years. Those with masters degrees taught an average of 17.88 (SD=10.16) years while those with only bachelor's degrees taught an average of 11.14 (SD=9.18) years. The average number of years at the present teaching position was 8.23 (SD=8.25). Many teachers taught more than one grade level which is common in rural Montana. Of the seventh and eighth grade teachers surveyed, 57 taught 6th grade and below, 111 taught 7th grade, 114 taught 8th grade, and 54 taught 9th grade and above. The average number of hours these teachers had for preparation time was 5.32 (SD=3.70). There were 65 (49.25%) of the 132 respondents who indicated that they had participated in science inquiry professional development. Of the 132 respondents, 40 (30.3%) indicated that they had experience working with a research scientist or in a research environment.

The mean TSI score was 4.08 (SD=0.39) on a scale that ranged from 1 to 5. On the instructional management (IM) subscale of the ABCC-R instrument, the mean score was 2.85 (SD=0.44) on a 1 to 4 scale. Participants' mean score on the people management (PM) subscale of the ABCC-R was 2.46 (SD=0.39). Statistical analysis of the details of the data was used to address the following research questions.

Research Question 1

1. What specific areas of 7th and 8th grade science teachers' background predict teachers' efficacy toward teaching science as inquiry?

The following teacher background variables and associated statistical test were analyzed to address this question: age (ANOVA), gender (t-test), highest level of education attained (t-test), science or non-science college major (t-test), science or non-science college minor (t-test), science or non-science teaching endorsement (t-test), years of teaching experience (ANOVA), years in present teaching position (ANOVA), grade level(s) taught (ANOVA), hours of preparation time/week (t-test), science inquiry professional development (t-test), and experience working with a research scientist or in a research environment (t-test). The ethnicity variable included in the survey was not analyzed since all but one respondent indicated that they were Caucasian. An OLS linear multiple regression analysis was used to identify the percent of the variation in self-efficacy toward teaching science as inquiry could be attributed to the variables in the regression.

Between Group Comparisons

From the application of the t-tests and analysis of variance (ANOVA) tests, statistical significance emerged with the following variables: highest college degree attained ($p=0.008$), science inquiry professional development experience ($p=0.000$), and experience working with a research scientist or in a research environment ($p=0.013$).

Teachers holding master's degrees had a statistically significant higher efficacy toward teaching science as inquiry score (TSI=4.18, SD=0.42) than those who held only bachelor's degrees (TSI=3.97, SD=0.46). Teachers with science inquiry professional development experience (TSI=4.22, SD=0.40) scored significantly higher on the TSI instrument than those without (TSI=3.94, SD=0.47). Participants who had experience working with a research scientist or in a research environment had significantly higher TSI scores (TSI=4.23, SD=0.48) than who had not had research experience (TSI=4.01, SD=0.43). No statistical significance was obtained with regards to participants' TSI scores among age, gender, college major or minor, teaching endorsement, years of teaching experience, years in present teaching position, grade levels taught, or hours of preparation time.

Regression Analysis

The ANOVA for the TSI scores produced a significance level of 0.014 indicating that the model is significant. Two predictor variables, Science Major (t=2.000, p=0.048) and Science Inquiry Experience (t=2.548, p=0.012), entered the regression equation accounting for 10.2% (Adjusted R^2 =0.102) of the variation in self-efficacy toward teaching science as inquiry F= 2.234, p=0.014. This indicates that teachers with a major in science with science inquiry professional development experience were more likely to have a greater self-efficacy toward teaching science as inquiry than teachers who did not have a major in science with any science inquiry professional development experience. The remaining teacher background variables were not significant predictors of teachers' self-efficacy toward teaching science as inquiry.

Based on the statistically significant findings for self-efficacy toward teaching science as inquiry, the null hypothesis for Research Question 1 is rejected. **Teachers with a major in science who have had science inquiry professional development experience are more likely to have a greater self-efficacy toward teaching science as inquiry than teachers without a science major who have not participated in science inquiry professional development.**

Research Question 2

What specific areas of 7th and 8th grade science teachers' background predict teachers' attitudes and beliefs on classroom control?

The following teacher background variables and associated statistical test were analyzed to address this question: age (ANOVA), gender (t-test), highest level of education attained (t-test), science or non-science college major (t-test), science or non-science college minor (t-test), science or non-science teaching endorsement (t-test), years of teaching experience (ANOVA), years in present teaching position (ANOVA), grade level(s) taught (ANOVA), hours of preparation time/week (t-test), science inquiry professional development (t-test), and experience working with a research scientist or in a research environment (t-test). The ethnicity variable included in the survey was not analyzed since all but one respondent indicated that they were Caucasian. An OLS linear multiple regression analysis was used to identify what percent of the variation in self-efficacy toward teaching science as inquiry could be attributed to the variables in the regression.

Between Group Comparisons

The two subscales of the ABCC-R inventory, instructional management (IM) and people management (PM) were analyzed separately. From the application of the t-tests and analysis of variance (ANOVA) tests, statistical significance did not emerge for the IM scores with any of the teacher background variables. The only variable with statistical significance with the PM scores occurred with regards to whether or not the participants had experience with a research scientist or in a research environment ($p=0.025$). Teachers with no research experience scored statistically higher on the PM subscale than those teachers who had research experience.

Regression Analysis

The overall IM regression model is not significant (p=0.120) indicating that with this population there are no variables that can be used as predictors of attitudes and beliefs in terms of the instructional management subscale of the ABCC-R inventory.

The ANOVA for the PM scores produced a significance level of 0.034 indicating that the model is significant. Two predictor variables, Prep Time (t= 2.367, p=0.020) and Science Research Experience (t=-3.251, p=0.001), entered the regression equation accounting for 8.1% (Adjusted R^2 =0.081) of the variation in self-efficacy toward teaching science as inquiry F=1.963, p=0.034. Because hours of preparation time per week were examined as a continuous variable and the coefficient was positive, teachers with more hours of prep time are more controlling with regards to their attitudes and beliefs on classroom control than teachers with less hours of prep time. This regression also indicates that teachers with science research experience were more likely to be less controlling with regards to their attitudes and beliefs toward classroom control than teachers without research experience. The remaining teacher background variables were not significant predictors of teachers' attitudes and beliefs on classroom control.

Based on the statistically significant findings for teachers' attitudes and beliefs on classroom control, the null hypothesis for Research Question 2 is rejected. **Teachers with science research experience who have fewer hours of preparation time per week are more likely to exert less control over their classroom.**

Research Question 3

What is the relationship between 7th and 8th grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control?

In order to investigate whether or not a relationship exists between teachers' efficacy towards teaching science as inquiry and their level of control as measured by teachers' attitudes and beliefs on classroom control, correlation analysis was conducted using the Pearson product moment correlation coefficient. No significant correlation between TSI scores and IM scores ($r=0.065$, $p<0.001$) and PM scores ($r=-0.069$, $p<0.001$**)** was observed. Thus, the research hypothesis that teachers' with higher efficacy towards teaching science as inquiry will statistically differ with regards to their attitudes and beliefs on classroom control in that they will conduct their instruction from a low control approach rather than one of high control when compared to teachers with lower efficacy toward teaching science as inquiry is rejected.

However, a significant linear relationship does exist between the IM and PM scores ($r=0.381$, $p<0.001$). Since this relationship is positive, when one of these subscales goes up, the other will as well.

Conclusions

Research Question 1

> What specific areas of 7th and 8th grade science teachers' background predict teachers' efficacy toward teaching science as inquiry?

Thirteen teacher background variables were examined with regards to their influence on teachers' self-efficacy toward teaching science as inquiry. Teachers with master's degrees, teachers with science majors, teachers with inquiry professional development experience, and teachers with experience working with a scientist or in a research environment scored significantly higher on the TSI instrument than teachers with bachelor's degrees, teachers without a science major, teachers with no inquiry professional development experience, and teachers who had no research experience, respectively.

Participants with master's degrees had significantly higher self-efficacy toward teaching science as inquiry than those participants with only bachelor's degrees. This study did not probe into the details of participants' master's degrees. Thus, whether these degrees were related to science, education, or any other discipline is unknown. If the master's degrees were in science, this supports Harlen's (1997) assertion that subject matter knowledge and the confidence to teach science are related. If the master's degrees were in education, an enhancement of pedagogical knowledge is assumed to have occurred which could affect teachers' confidence toward facilitating the demands of inquiry-oriented instruction. Modification of pedagogy has been demonstrated as a positive influence towards transforming a traditional approach to science instruction to one of an inquiry-based approach (Nelson, 2001). Nearly half of the participants in this study (46.9%) had at least a master's degree which in some part indicates these Montana teachers' commitment to their profession.

It stands to reason that participants in this study who have had no professional development in teaching science as inquiry would possess less confidence about their abilities toward teaching science as inquiry than those who have engaged in science inquiry professional development. While participants without professional development experience may have engaged in some inquiry-related activities through other experiences, many teachers have a false conception of inquiry (Anderson, 2002). Added to this is the assertion that most teachers have not had sufficient and effective scientific inquiry experiences (Hahn & Gilmer, as cited in Abd-El-Khalick et al., 2004; Shapiro, 1996; Windschitl, 2000), the need for science inquiry professional development among practicing teachers is evident. Taitelbaum, Mamlok-Naaman, Carmeli, & Hofstein (2008) describe an inquiry teaching five-day summer induction course and subsequent three-hour workshops that were conducted once a month for seven months. Included in this program were the videotaping of participants' instruction and an online closed internet forum for discussion. This program resulted in a significant change in teachers' pedagogical knowledge and content knowledge toward teaching science as inquiry. The Office of Public Instruction for the state of Montana recognizes this need and notified school districts during the fall of 2008 of plans to send facilitators across the state to train teachers in inquiry-based instruction. A copy of this document appears in Appendix K.

Research experience can profoundly change science teachers' views of teaching science (Brock, 1999). Dresner (2002) describes a 6-week summer research experience in which teachers participated in forest ecology fieldwork. Teachers' motivation, confidence, knowledge and skills in science teaching were greatly enhanced from their contact with scientists in a field experience. This produced a shift in teachers' understanding about teaching science as inquiry and their ability to pass inquiry-related skills on to their students. The inquiry process suggested for the study of science in classrooms closely mirrors that of the processes that scientists utilize when conducting investigations and experimentation. Results from the present study indicate that teachers who have participated in research with a scientist or worked in a research environment have a greater self-efficacy toward teaching science as inquiry. Because these teachers have participated in a research setting, their understanding of the research process is a confidence booster as observed by their higher TSI scores.

The effects of a science background are evidenced in science instruction with those teachers possessing a greater background in science exhibiting a higher level of science teaching effectiveness as well as a being greater promoters of inquiry-based instruction (Abell, 2007; Harlen, 1997; Newton & Newton, 2001). While the science major variable did not appear as significant in the between group comparison analysis, it did emerge in the multiple linear regression when combined with science inquiry professional development experience. An important and educational component of college science coursework is students' laboratory investigations. Through these activities, students are more likely to experience the scientific processes, including inquiry, at a variety of levels. The potential to carry over these experiences to their teaching is palpable.

The specific teacher background variables in this study that had the greatest connection to teachers' self-efficacy toward teaching science as inquiry were not surprising. Bringing these components to the forefront of the science reform movement as it pertains to inquiry-oriented instruction seems more than reasonable and helps to identify more reasons as to why teachers are not conducting inquiry-based instruction to the extent that they should be. Just as important as what does significantly influence inquiry beliefs is the separation out of background variables that do not appear to have an influence. The implications and suggestions for addressing these findings are discussed in the next section of this chapter.

Research Question 2

> What specific areas of 7th and 8th grade science teachers' background predict teachers' attitudes and beliefs on classroom control?

Classroom management and control continues to be a major concern of teachers (Emmer & Stough, 2001; Goyette et al., 2000; Parsad et al., 2000). Teaching science as inquiry can test teachers' management and control skills often to a greater degree compared to teacher-lead strategies. Analysis of the instructional management (IM) data from the ABCC-R instrument revealed no significant findings with regards to the 13 teacher background variables in both the between group comparisons and the regression equation. This suggests that in this study the daily routines such as the distribution of materials and the supervision of students working independently was fairly equal among participants in terms of being more controlling or less controlling. However, the number of independent variables that could be created that could be analyzed with the IM dependent variable is potentially endless. The conclusion drawn from this subscale is that teachers employ what works best for them in their given and unique settings.

With the people management (PM) subscale of the ABCC-R instrument, one variable did emerge as significant in the between group comparisons. Teachers with prior scientific research experience were less controlling than teachers with no science research background. This suggests that these teachers understand the importance of student autonomy in the facilitation of science instruction. Student autonomy is an important component of learning by inquiry and teachers with high self-efficacy beliefs are more likely to provide and foster autonomous learning environments (Leroy et al., 2007). The finding regarding people management dovetails nicely with the finding that teachers with science research experience had significantly higher self-efficacy towards teaching science as inquiry than those teachers without prior science research experience. The science research experience variable appeared again in the linear regression as one of the two components that can be considered a predictor of lower control over students with regards to teacher-student relationships and how these are developed and maintained. The other predictor variable, hours of preparation time per week, suggests that teachers with less than five hours of preparation time per week are less controlling than those teachers with five or more hours of preparation time per week. Peter (1991) reports that teachers' approach to planning depended upon their attitudes, beliefs, values and concerns. The participants in his study felt that subject content knowledge was one of the most significant concerns. Zohorik (1975) found that time spent addressing content is one of the most important items when it comes to planning decisions whereas organization and instruction are relatively unimportant to teachers. Although no obvious conclusion is apparent from the finding in the present study, perhaps people management skills are more affected by internal personality traits than external background experiences. Control may also be mitigated by the decrease in contracted planning hours and the affect this has on the level of complexity of the science instruction designed and implemented by the teachers. Fewer hours of preparation may lead to simpler lessons that don't require a heavy hand of control.

Research Question 3

> What is the relationship between 7th and 8th grade science teachers' efficacy toward teaching science as inquiry and their attitude and beliefs on classroom control?

Science teachers with high self-efficacy tend to foster a student-centered learning environment (Leroy et al., 2007) which is an important part of effective inquiry-based instruction. While not addressing science inquiry specifically, Gencer and Cakiroglu (2007) found an unexpected significant positive correlation between personal science teaching efficacy and the instructional management subscale of the ABCC instrument indicating that as respondents' confidence to teach science increased, the more controlling they tended to be. Furthermore, in that study science teachers with higher self-efficacy were less controlling in the teacher-student relationships as measured by the people management subscale. No such relationships were found in the present study. The study by Yilmaz and Cavas (2008) yielded a similar result though they examined the relationship between teachers' general science teaching self-efficacy and classroom control rather than teachers' self-efficacy toward teaching science as inquiry and classroom control.

Results from the present study indicate that whether teachers are more controlling or less controlling in their classroom control has no significant relationship with their self-efficacy toward teaching science as inquiry. Perhaps this relationship is more complex than what the TSI and ABCC-R instruments are capable of capturing in the type of correlational analysis performed. While students are given greater freedom to construct knowledge through inquiry investigations, this must be conducted under an umbrella of structure in order to prevent ineffective learning and off-task behaviors. This is particularly important at the seventh and eighth grade levels given this age group's level of maturity and often discombobulated social interaction skills. According to Colburn (2000), effective science instruction occurs in a disciplined classroom. Science teachers who are the most successful make sure that students understand the class rules, understand directions, and stay within the guidelines set forth by the teacher (Fraser & Tobin, 1989). Capturing the best practices for classroom management and control in inquiry-oriented science instruction is one of the suggestions made in the section on areas for future research.

The correlational analysis did reveal a significant relationship between the instructional management (IM) and people management (PM) scores of the ABCC-R inventory. This was a positive relationship indicating that when one of these variables goes up, the other does as well. While beliefs are context specific, the idea that attitudes and beliefs of teachers regarding classroom control along the two subscales of the ABCC-R instrument are consistent seems reasonable, and no study was uncovered that suggests otherwise when only the relationship between these two variables is examined.

Implications

"Of the many steps needed to improve science education,
none is more important than improving teacher training."
(Wenglinsky & Silverstein, 2006, p.29).

There are no quick fixes towards the implementation of inquiry-based instruction (Colburn, 2004). The present study and those that came before have attempted to examine barriers and influences that are preventing the inquiry component of science reform from moving forward. Whether or not science teachers practice inquiry is influenced by a variety of factors, but none may be more important than teachers' beliefs (Lumpe and Haney, 1998). The origins of teachers' beliefs toward teaching science as inquiry are deep and complex. Experience as a student, work and recreational experiences, and teacher education programs are just a few of the influences that shape teachers' perceptions of inquiry. But in spite of background, beliefs can be changed. The task before those who are championing the cause for inquired-based instruction in today's science classrooms need to address the preservice experience for prospective teachers as well as influence the instruction of practicing teachers.

Preservice Inquiry and Self-Efficacy

In teacher preparation programs, monitoring the self-efficacy of preservice teachers may be insightful in understanding how novice science teachers develop confidence toward teaching science as inquiry. Enochs and Riggs (1990) believe that early detection of low self-efficacy in elementary science teaching is vital in teacher preparation programs. To accomplish this, an awareness of the impact of self-efficacy on preservice teachers becomes a responsibility of college professors and may require a modification in the way that many of those in the departments of education conduct their instruction. To address self-efficacy beliefs among preservice teachers, Tschannen-Moran and Hoy (2001) suggest an apprenticeship approach in teacher preparation programs in which Bandura's vicarious experience and verbal persuasion typically found in university classes is replaced with mastery teaching experiences. They further suggest that the student teaching experience should not be sink-or-swim but rather a gradual withdrawal of scaffolding and support. Mulholland and Wallace (2001) would like to see a restructuring of the preservice field experiences. They suggest that field service placements should include mastery experiences that are monitored carefully by inservice supervisors. They further add the importance of appropriate modeling of science strategies by college instructors so that the preservice teachers can enhance their self-efficacy toward teaching science through vicarious experiences which ultimately aids new teachers in their development of mastery skills. To further support the contention that mastery experiences are vital, Brand and Wilkins (2007) discovered that mastery experiences were the most influential at influencing preservice teachers' teaching self-efficacy beliefs though there appears to be an interrelationship between mastery experiences and the other three sources. To gain confidence in inquiry teaching which ultimately impacts subsequent practice in the classroom, preservice teachers need to have a clear and concrete understanding of what science inquiry is and how to conduct it.

Studies conducted with regards to inquiry in teacher preparation programs indicate a desperate need for such experiences and preservice teachers should have the opportunity to engage in inquiry as part of their teacher education coursework (Windschitl, 2003; Windschitl & Thompson, 2006). Perkins-Gough (2006) claims that undergraduate teacher education programs rarely prepares students for the pedagogical and science content demands necessary to address science processes and important science content. Kang (2008) feels that preservice teachers should be provided with inquiry-oriented content courses that address subject matter knowledge in order for prospective teachers to be better prepared for reform-oriented teaching. Science methods courses that emphasize inquiry are only part of the solution. Roehrig and Luft (2004) found that when viewed independently, teachers' content knowledge, teaching beliefs, and pedagogical knowledge were not predictive in teachers' execution of inquiry-based instruction. They conclude that these factors work collectively rather than independently with regards to influencing teaching practice. For beginning teachers, teaching science as inquiry is the cumulative effect of knowledge, supporting beliefs, prior experiences and current experiences. A well-rounded inquiry instruction experience should also include time dedicated to reflection. Melville, Fazio, Bartley, and Jones (2008) state that, "the opportunity for preservice teachers to reflect on their experiences is an imperative in the encouragement of inquiry" (p. 479). This can be accomplished through reflective writing, classroom discourse and seminars with practicing teachers from local schools.

The extent to which inquiry is a component of teachers' preparation work in science instruction can vary from one institution to another. However, even college science methods courses that involve inquiry projects for students may not be able to serve as a substitute for science research experiences. Windschitl (2003) found that preservice teachers' practice of inquiry was most strongly associated with previous research experience. He further suggests that undergraduate students need authentic research experiences working with scientists in a research environment. Content courses that include scientists could be useful in helping preservice teachers gain a greater understanding of inquiry and how it's used in scientific research. Eick and Reed (2002) found that inquiry-oriented teachers had inquiry identities that were based on past experiences which included model science course for teachers and experience working with scientists.

Inservice Inquiry and Self-Efficacy

For veteran science teachers, many with scores of years of experience, one the best opportunities for increasing self-efficacy toward teaching science as inquiry lies with self-efficacy professional development (Ross and Baker, 2007). Referring to Bandura's four sources of self-efficacy, Mulholland and Wallace (2001) found that mastery and social persuasion greatly enhanced science teaching self-efficacy whereas vicarious experience and physiological states did not. This should be taken into account in the design of self-efficacy professional development. While changes in self-efficacy are possible, one-shot workshops tend to be ineffective (Henson, 2001). Many components of professional development must be considered if that experience is to be effective (Loucks-Horsley, Hewson, Love, & Stiles, 1998). Building capacity for sustainability is a key indicator of the commitment towards aiding teachers in their professional growth. This is evidenced by the study in which Supovitz et al. (2000) observed significant growth in their participants' practice of inquiry-based instruction which they attribute to the high-quality and intensive training that these teachers experienced during professional development activities in inquiry over the course of three years.

Learning to teach inquiry takes time, and while it is possible to develop the content and pedagogical knowledge to be successful, professional development not only expedites this transformation, it does so in a more meaningful way (Taitelbaum et al., 2008). Like self-efficacy, professional development regarding inquiry that is conducted as a short-term experience in inquiry may be an insufficient agent of change (Akerson & Hanuscin, 2007; Lotter, Harwood, & Bonner, 2007; Smith et al., 2007). Constraints to the practice of science inquiry can be mitigated with professional development programs that target student-centered and inquiry-based instruction (Luft, Roehrig, & Patterson, 2003). In order for teachers to be able to understand and effectively implement the inquiry approach to science instruction, they must undergo a comprehensive professional development program that addresses the same skills, knowledge and thinking habits that they will expect of their students (Windschitl, 2003). Luft et al. (2003) suggest workshops that provide pedagogical knowledge for conducting inquiry and classroom observations by experienced teachers of inquiry. According to the findings of Smith et al. (2008), it was only after 80 hours of professional development that teachers reported a significant increase in the use of inquiry over teachers who had no inquiry professional development experience. Gejda and LaRocco (2006) also suggest that 80 hours of professional development in inquiry-based instruction is the minimum in order to be effective.

Just learning some new techniques does not constitute a change in educational practices. While professional development is an important component in the process of change, it must be a transformative process and routine inservice alone is not sufficient (Anderson, 2007). If teachers can become dissatisfied with their past beliefs and are presented with viable alternative practices, connection with new beliefs and new practices are possible (Anderson, 2002), especially if teachers are convinced that new practices will produce greater student learning (Prawat, 1992). Collaboration with colleagues can be a very powerful influence in this transformation. Wee, Shepardson, Fast and Harbor (2007) suggest that after inquiry professional development, a follow-up agenda should be provided that allows teachers the opportunity to work collaboratively by reviewing each others' inquiry instruction and to provide feedback. Davis (2002) recommends reflection through inservices that provide teachers opportunities to share strategies and provide examples of what worked in their classrooms. Anderson (2002) states, "Collaboration is a powerful stimulus for the reflection which is fundamental to changing beliefs, values and understandings" (p. 9). With professional development, teachers' attitudes and beliefs change, teachers' practices change, and the learning outcomes of students change (Guskey, 1986).

Professional development should include direct experiences with science research resembling that found in research settings (Abd-El-Khalick et al., 2004). Even though many practicing teachers are no longer connected to colleges through coursework, this is no reason to discount opportunities to participate in science research. Summer research programs like Columbia University's Summer Research Program for Secondary School Science Teachers provides participating teachers the opportunity to interact with science scholars and engage in laboratory research (Wenglinsky & Silverstein, 2006). The impact of such an experience can be profound. Wenglinsky and Silverstein claim, "It is possible that one in-depth experience in the practice of science can change an entire teaching career" (p. 28). The National Science Teachers Association regularly lists partnerships, internships and other opportunities for teachers to work with scientists in research environments. Volunteer organizations like Trout Unlimited, Ducks Unlimited, and Pheasants Forever often work with state and federal agencies on a variety of local fish and wildlife research projects that science teachers could pursue.

Classroom Management and Control

While the present study did not find a relationship between self-efficacy towards teaching science as inquiry and teachers' beliefs toward classroom control in terms of being controlling or not controlling, successful classroom management skills are important for effective inquiry-based instruction (Baker et al., 2002; Lawson, 2000). Fraser and Tobin (1989) describe exemplary science teachers as ones who monitor student engagement and understanding in a thoughtful, systematic and routine manner. With exemplary science teachers, students understand rules and understand directions. While Colburn (2000) feels that teachers must allow students some element of control over their science learning, he insists that an effective inquiry-oriented teacher must maintain a disciplined classroom. Unfortunately, classroom management is often short-changed in teacher preparation programs (Henson, 2001). This has implications for the provision of a classroom management and control for inquiry component in science methods coursework.

Even though classroom control had no significant relationship with teachers' efficacy toward teaching science as inquiry in this study, this does not discount the value of the analysis. While this finding could be a product of the instrument, it could also illustrate that attitudes and beliefs on classroom control are not important barriers toward the practice of inquiry-oriented instruction. Eliminating those factors that pose no influence on science inquiry self-efficacy is just as valuable as identifying those that do.

Future Research

Issues surrounding the promotion and practice of inquiry-based instruction are far from being resolved. While the present study shed light on factors that influence teachers' self-efficacy toward teaching science as inquiry, areas for future research on this topic arose. The first issue concerns the self-reported survey instruments. Teacher self-efficacy has produced positive educational outcomes. However, most of the research with this construct has been with self-report measurements and correlational analysis (Fives, 2003). While Mayer (1999) found a 0.85 correlation between his observational data and survey data, it would warrant an examination of teachers' actual practices in comparison to their responses on the TSI and ABCC-R inventories. Interviews, observations, and/or case studies would be revealing in terms of the depth of teachers' beliefs toward science as inquiry and any relationship with their attitudes and beliefs on classroom control.

Teacher self-efficacy has been explored deeply with regards to the teaching of science. However, the component of inquiry and self-efficacy has not. The TSI instrument, while valid and reliable (Smolleck et al., 2006), is a recent tool for examining the self-efficacy of teachers with regards to inquiry-oriented instruction. This instrument needs further applications in order to investigate its potential predictive soundness. While the present study targeted all Montana seventh and eighth grade science teachers, Montana is a small state in terms of overall population, thus the sample population in this study was relatively small. Additionally, as evidenced by the schools and teachers surveyed, the sample population has a large rural component with almost exclusively Caucasian teachers. The TSI instrument should be applied to larger sample sizes, administered to different K-12 grade level groupings, examine both urban and rural educational settings, and involve teachers of ethnic and racial diversity.

Many factors influence teachers' teaching beliefs. This makes for a complex equation when examining factors affecting the practice of science inquiry instruction. Although several teacher background variables were examined in this study, many others may prove valuable towards honing in on important factors affecting teachers' self-efficacy toward teaching science as inquiry. While this study indicated that teachers with research experience had higher self-efficacy toward teaching science as inquiry, Marshall et al. (2008) reported that science teachers with prior careers in Science, Technology, Engineering and Math (STEM) devoted a lower percentage of time to inquiry and indicated a lower ideal percentage of instructional time that should be devoted to inquiry.

Taitelbaum et al. (2008) contend that science teachers not only need content knowledge but the appropriate pedagogical knowledge in order to be effective. An examination of content-specific pedagogical understandings may be an important missing skill linked to inquiry-based self-efficacy that needs further examination.

While speculative, it stands to reason that many if not most of Montana's science teachers are products of Montana colleges. Information on where the participants gained their preservice experience was not gathered in this study. Doing so might provide insight as to what colleges are doing in order to provide better preparation for teaching science as inquiry. Course listings and analysis of syllabi would provide data that could be linked to inservice teachers' extent to which they practice inquiry-oriented instruction.

Teacher beliefs are subject to change. While Andersen et al. (2004) examined new elementary teachers' efficacy three times over the course of the year, long-term studies of the formation and evolution of teachers' self-efficacy are needed. Longitudinal studies would document changes and identify the significant factors that affect change.

The Tschannen-Moran et al. (1998) model in Figure 2 describes efficacy as a cyclical construct. Ways to influence teachers' self-efficacy toward teaching science as inquiry is the next step researchers need to take in order to broaden the positive outcomes associated with higher teacher self-efficacy.

Even thought the present study revealed no correlation between self-efficacy toward teaching science as inquiry and teachers' attitudes and beliefs toward classroom control, the potential for a relationship exists when considering the management skills necessary to effectively facilitate inquiry-oriented teaching strategies. With regards to this, several questions worthy of investigation arise: What are the best practices for classroom management with regards to delivering inquiry-based instruction? Is there a viable difference between perceived science classroom management styles and actual science classroom management styles? What influence do student population characteristics have on classroom control strategies in relation to science inquiry instruction strategies?

Several of the independent variables in the study did not exhibit significance in the analysis yet were close to the cut-off of $\alpha = 0.05$. Does this mean that they should be eliminated in perpetuity from future study or is this evidence that additional research is warranted? At the very least, if not significant, findings close to significance are informative and would add to the generalizability of the study. Therefore, the list of areas for future research could be easily extended.

The call for further research investigating the self-efficacy construct in relation to science education reform has been sounded (Cannon & Scharmann, 1995; Cantrell et al., 2003; Smolleck & Yoder, 2006; Smolleck et al., 2006; Tosun, 2000; Tosun, 2001; Tschannen-Moran & Hoy, 2001). Science teaching reform cannot advance without science teacher reform. With this in mind, science teacher self-efficacy is not a static concept. The more research gathered with regards to science teachers’ self-efficacy toward teaching science as inquiry, the closer we can get towards advancing effective inquiry-oriented instruction in our science classrooms.

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APPENDIX A

Teacher Background Survey

Background Survey

Please fill in the blanks and circle the appropriate responses.

Age: _______ **Gender:** Male Female

Ethnicity: African American Caucasian Hispanic Native American Other

Highest Educational Level: Bachelor's Master's Education Sp. Doctorate Other

Major Area(s) of Study:____

Minor Area(s) of Study:____

Teaching Endorsements (circle all that apply): Provisional Elementary K-8

Broadfield Science Physical Science Biological Science Physics

Chemistry Biology Earth Science

Other(s) ____

Years of Teaching Experience: _______ **Years in Present Science Teaching Position:** _______

Grade Level(s) Taught: ________________

Hours of preparation time provided per week (prep period hours): ___________

Hours of Science Inquiry Professional Development: ____________

Experience Working with a Research Scientist or in a Research Environment: none or describe briefly below:

APPENDIX B

Teaching Science as Inquiry (TSI) Instrument

Teaching Science as Inquiry (TSI)

Please indicate the degree to which you agree or disagree with each statement below by circling in the appropriate number as indicated: 5 = Strongly Agree 4 = Agree 3 = Uncertain 2 = Disagree 1 = Strongly Disagree

Please indicate the degree to which you agree or disagree with each statement below by circling in the appropriate number as indicated below:

When I teach science…

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. I am able to offer multiple suggestions for creating explanations from data.	5	4	3	2	1
2. I am able to provide students with the opportunity to construct alternative explanations for the same observations.	5	4	3	2	1
3. I am able to encourage my students to independently examine resources in an attempt to connect their explanations to scientific knowledge.	5	4	3	2	1
4. I possess the ability to provide meaningful common experiences from which predictable scientific questions are posed by students.	5	4	3	2	1
5. I have the necessary skills to determine the best manner through which children can obtain scientific evidence.	5	4	3	2	1
6. I am able to provide opportunities for students to become the critical decision makers when evaluating the validity of scientific explanations.	5	4	3	2	1
7. I am able to guide students in asking scientific questions that are meaningful.	5	4	3	2	1
8. I am able to provide opportunities for my students to describe their investigations and findings to others using their evidence to justify explanations and how data was collected.	5	4	3	2	1
9. I am able to negotiate with students possible connections between/among explanations.	5	4	3	2	1
10. I encompass the ability to encourage students to review and ask questions about the results of other students' work.	5	4	3	2	1
11. I am able to guide students toward appropriate investigations depending on the questions they are attempting to answer.	5	4	3	2	1
12. I am able to create the majority of the scientific questions needed for students to investigate.	5	4	3	2	1
13. I possess the ability to allow students to devise their own problems to investigate.	5	4	3	2	1
14. I am able to play the primary role in guiding the identification of scientific questions.	5	4	3	2	1
15. I am able to guide students toward scientifically accepted ideas upon which they can develop more meaningful understanding of science.	5	4	3	2	1
16. I possess the abilities necessary to provide students with the possible connections between scientific knowledge and their explanations.	5	4	3	2	1
17. I possess the skills necessary for guiding my students toward explanations that are consistent with experimental and observational evidence.	5	4	3	2	1

When I teach science…	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
18. I am able to encourage students to gather the appropriate data necessary for answering their questions.	5	4	3	2	1
19. I am able to offer/model approaches for generating explanations from evidence.	5	4	3	2	1
20. I am able to coach students in the clear articulation of explanations.	5	4	3	2	1
21. Through the process of sharing explanations, I am able to provide students with the opportunity to critique explanations and investigation methods.	5	4	3	2	1
22. I am able to facilitate open-ended, long-term student investigations in an attempt to provide opportunities for students to gather evidence.	5	4	3	2	1
23. I am able to help students refine questions posed by the teacher or instructional materials, so they can experience both interesting and productive investigations.	5	4	3	2	1
24. I am able to provide demonstrations through which students can focus their queries into manageable questions for investigation.	5	4	3	2	1
25. I am able to utilize worksheets as an instructional tool for providing a data set and walking students through the analysis process.	5	4	3	2	1
26. I am able to model for my students prescribed steps or procedures for communicating scientific results to the class.	5	4	3	2	1
27. I am able to provide my students with possible connections to scientific knowledge through which they can relate their explanations.	5	4	3	2	1
28. I am able to provide my students with evidence to be analyzed.	5	4	3	2	1
29. I am able to provide my students with the data needed to support an investigation.	5	4	3	2	1
30. I am able to provide my students with all evidence required to form explanations through the use of lecture and textbook readings.	5	4	3	2	1
31. I am able to model for my students the guidelines to be followed when sharing and critiquing explanations.	5	4	3	2	1
32. I am able to instruct students to independently evaluate the consistency between their own explanations and scientifically accepted ideas.	5	4	3	2	1
33. I am able to construct with students the guidelines for communicating results and explanations.	5	4	3	2	1
34. I am able to provide my students with explanations.	5	4	3	2	1

APPENDIX C

Attitudes and Beliefs on Classroom Control - Revised (ABCC-R) Instrument

Attitudes and Beliefs of Classroom Control-Revised (ABCC-R) Inventory

Please circle the response that best describes you.

Describes me well	*Describes me usually*	*Describes me somewhat*	*Describes me not at all*
4	3	2	1

Describes me…	Well	Usually	Some	Not
1. I believe students can manage their own learning behavior during seatwork.	4	3	2	1
2. When a student is repeatedly off-task, I will most likely remove a privilege or require detention.	4	3	2	1
3. I believe that students should create their own daily routines as this fosters the development of responsibility.	4	3	2	1
4. I believe class rules are important because they shape the student's behavior and development.	4	3	2	1
5. The teacher knows best how to allocate classroom materials and supplies to optimize learning.	4	3	2	1
6. While teaching a lesson on library skills, a student begins to talk about the research she is doing for her book report. I would remind the student that the class has to finish the lesson before the end of the class period.	4	3	2	1
7. When moving from one learning activity to another, I will allow students to progress at their own rate.	4	3	2	1
8. The classroom runs more smoothly when the teacher assigns students to specific seats.	4	3	2	1
9. I believe teachers should give students freedom so they will develop their own ways of interacting with each other.	4	3	2	1
10. I do not specify a set time for each learning activity because that can only be determined by the students.	4	3	2	1
11. If students believe that a classroom rule is unfair, I may explain the reason for the rule but would not change it.	4	3	2	1

Describes me…	Well	Usually	Some	Not
12. I believe student's emotions and decision-making processes must always be considered fully legitimate and valid.	4	3	2	1
13. Students in my classroom are free to use any materials they wish during the learning process.	4	3	2	1
14. I believe students will be successful in school if allowed the freedom to pursue their own interests.	4	3	2	1
15. I believe students will be successful in school if they listen to adults who know what's best for them.	4	3	2	1
16. I believe that friendliness, courtesy, and respect for fellow students is something that students have to learn first-hand through free interaction.	4	3	2	1
17. During the first week of class, I will announce the classroom rules and inform students of the penalties for disregarding the rules.	4	3	2	1
18. When a student bothers other students, I will immediately tell the student to be quiet and stop it.	4	3	2	1
19. I believe teachers should require student compliance and respect for law and order.	4	3	2	1
20. I believe that students should choose the learning topics and tasks.	4	3	2	1

APPENDIX D

Letter to Administrator

Dr. Lisa Blank, Advisor • University of Montana • School of Education • Missoula, MT 59812

Dear Administrator,

My name is Tim Joern and I teach 8th grade Physical Science in Whitefish, MT. I am currently a doctoral candidate working on my dissertation in Curriculum and Instruction. The title of my study is: Investigating the Relationships between Middle School Science Teachers' Background and Experience, Efficacy Regarding the Teaching of Science as Inquiry, and Attitudes and Beliefs toward Classroom Management and Control.

Inquiry-based science instruction is an overarching goal of our state and the national science standards. The purpose of this study is to examine relationships between middle school science teachers' background and experience, their efficacy toward teaching science as inquiry, and classroom management and control. From this study new information will surface that could be used to understand how to help middle school science teachers become better practitioners of inquiry-based science instruction. This study has been approved by the Institutional Review Board at the University of Montana.

In the package you received you will find enough packets for the estimated number of middle school science teachers (grades 6-8) in your building. Each packet will contain the following:

- Cover letter explaining the purpose and importance of the study
- Information letter and consent to participate
- Instructions for completing the instruments
- The three survey instruments
- A pre-addressed, postage-paid envelope
- "Lucky" card for free drawing

I hope that you will encourage your teachers to participate in this study. Time to complete the survey is approximately 20 minutes. Participation is voluntary and all information provided by the teachers will be anonymous. After completing surveys, each teacher will be asked to place them in the pre-addressed, postage-paid envelope and place in outgoing mail via the United States Postal Service. Upon receipt by the researcher, the envelope will be separated from the data so there will be no identifiers as to where the data came from.

Thank you very much for considering allowing your teachers to participate in this study. Your support is greatly appreciated. Please do not hesitate to contact me if you have any questions.

Sincerely,

Tim Joern
joernt@wfps.k12.mt.us
406-862-1490

APPENDIX E

Letter to Teacher Participants

Dr. Lisa Blank, Advisor • University of Montana • School of Education • Missoula, MT 59812

Dear Science Teacher Colleague,

My name is Tim Joern and I am currently a doctoral candidate working on my dissertation in Curriculum and Instruction. The title of my study is: Investigating the Relationships between Seventh and Eighth Science Teachers' Background, Efficacy Regarding the Teaching of Science as Inquiry, and Attitudes and Beliefs toward Classroom Control.

Inquiry-based science instruction is an overarching goal of our state and the national science standards. The purpose of this study is to examine relationships between 7th and 8th science teachers' background, their efficacy toward teaching science as inquiry, and attitudes and beliefs toward classroom control. From this study new information will surface that could be used to understand how to help middle school science teachers become better practitioners of inquiry-based science instruction. This study has been approved by the Institutional Review Board at the University of Montana.

In the package you received you will find the following:

- This cover letter explaining the purpose and importance of the study
- Information letter and consent to participate
- Instructions for completing the instruments
- The three survey instruments
- A pre-addressed, postage-paid envelope
- "Lucky" card for free drawing

I hope that you will consider participating in this study. Time to complete the survey is approximately 15 minutes. Participation is voluntary and all information you provide will be anonymous. After completing surveys, place them in the pre-addressed, postage-paid envelope and place in outgoing mail via the United States Postal Service. Upon receipt by the researcher, the envelope will be separated from the data so there will be no identifiers as to where the data came from. Don't forget to send me the Lucky postcard for your chance to win an iPod Nano. Good luck!

Thank you very much in advance for your help. Your support is greatly appreciated. Please do not hesitate to contact me if you have any questions. I hope the remainder of your school year is prosperous and rewarding. Keep up the fine work you are doing with our Montana students.

Sincerely,

Tim Joern
joernt@wfps.k12.mt.us
406-862-1490

APPENDIX F

Information Letter about the Study

Title of Study

Investigating the Relationships between Seventh and Eighth Science Teachers' Background, Efficacy toward the Teaching of Science as Inquiry, and
Attitudes and Beliefs toward Classroom Control

Principal Investigator: Tim Joern

A. Introduction and Purpose

The purpose of this study is to examine the relationships between 7^{th} and 8^{th} grade science teachers' background, efficacy towards teaching science as inquiry and attitudes toward classroom control. Information derived from this study will add to the existing research that addresses ways to help middle school science teachers to enhance their inquiry-based science instruction.

B. Procedure

The participants are asked to complete three survey instruments: The Background Questionnaire, the Teaching Science as Inquiry (TSI) Instrument, and the Attitudes and Beliefs of Classroom Control (ABCC-R) Inventory. It is estimated that it will take 15 minutes to complete the instruments.

C. Benefits

There are no benefits to the participants other than self-reflection of their instructional practices and the chance to win an iPod Nano through a random drawing.

D. Risks

There are no apparent risks associated with participation in this study. In the unlikely event of an injury arising from participation in this study, no reimbursement, compensation, or free medical treatment is offered by the University of Montana or the researcher.

E. Voluntary Participation/Withdrawal

Participation is voluntary. Participants can start and stop without any penalty. Survey responses will not be identifiable by person, school building or school district. Upon receipt by the researcher, the envelope containing the data will be separated from the data so there will be no identifiers as to where the data came from. Surveys mailed can not be withdrawn since they will not be identifiable by participant.

F. Costs

There are no costs associated with participation in this study.

G. Compensation

Compensation is not provided for those who participate other than having the opportunity to win an iPod from a drawing to be held for those who choose to participate.

H. Confidentiality

All information collected from this study will be held in confidence to the extent permitted by law. All information will be presented in aggregate form with no individual participant identifiable in the study.

I. Questions

Any questions regarding the surveys or purpose of this study can be addressed by contacting the principal investigator, Tim Joern, at 406-862-1490 or at joernt@wfps.k12.mt.us. The University of Montana contact is Dr. Lisa Blank who is available at 406-243-5304 or at lisa.blank@mso.umt.edu.

J. Consent to Participate in a Research Trial

The return of your completed survey is evidence of your willingness to participate in this study. Please retain this information sheet in case you have any questions or would like additional information regarding this study.

APPENDIX G

Survey Instructions

Survey Instructions

There are three parts to the survey. Each part is simple to complete and summarized below.

Background and Experience Survey

This component is designed to obtain demographic, teaching experience and professional data. For the last question, *Experience Working with a Research Scientist or in a Research Environment*, choose “none” if applicable or briefly describe your experience in a science research setting.

Teaching Science as Inquiry (TSI-2) Instrument

This instrument captures your efficacy or confidence with regards to teaching science as inquiry. For each of the questions, circle the appropriate number ranging from 5-Strongly Agree to 1-Strongly Disagree.

Attitudes and Beliefs of Classroom Control (ABCC-R) Inventory

The ABCC-R inventory addresses two dimensions: Instructional Management and People Management. These questions provide insight as to your beliefs about your classroom control. For each of the questions, circle the appropriate number ranging from 4-Describes me well to 1-Describes me not at all.

All Done – A Big Thanks to You!

Upon completion, fold the survey and put it in the pre-addressed, postage-paid envelope and place in outgoing mail via the United States Postal Service. Fill-out the postage-paid postcard for your chance to win an iPod Nano and mail it separately from the survey materials. This chance for the prize is based on the honor system.

APPENDIX H

Incentive Postcard

Win an iPod Nano!

Upon completion and mailing of the survey, provide the information necessary to contact you if you win.

Name: ____

Best way to contact you (email, address, or phone number):

____

APPENDIX I

Reminder Postcard

Survey: Investigating the Relationships between Seventh and Eighth Science Teachers' Background, Efficacy toward the Teaching of Science as Inquiry, and Attitudes and Beliefs toward Classroom Control

Dear Administrators,
Thank you for passing on the surveys to your teachers. Could you please pass on this reminder postcard? Thanks.

Dear Teachers,
Thank you if you've completed the surveys. If not, I hope you have time to do so. It's not to late to get entered in the drawing for the iPod.

Sincerely, Tim Joern
joernt@wfps.k12.mt.us
(406) 862-1490

APPENDIX J

IRB Committee Approval

#71-08

The University of **Montana**

Legal Counsel
Main Hall, Room 133
The University of Montana
Missoula, Montana 59812-3528
Phone: (406) 243-4742
FAX: (406) 243-2797

Date: **March 17, 2008**

To: **William (Tim) Joern and Lisa Blank, C & I**

From: **Claudia Denker, IRB Chair**

RE: **IRB approval of your proposal #71-08**

Your IRB proposal has been determined to be exempt from IRB review under:

45 CFR 46.101(b)(2): Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i)Information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

University of Montana IRB policy does not require you to file an annual Continuation Reports (Form RA-109) for exempt studies. However, you are required to timely notify the IRB if there are any significant changes or if unanticipated or adverse events occur during the study, if you experience an increased risk to the participants, or if you have participants withdraw from the study or register complaints about the study. Finally, when you terminate the study, please notify our office in writing so that we can close the file.

Claudia D. Denker

Claudia D. Denker

[attachment(s)]

Appendix K

Montana Science Standards Training for Trainers

WM-CSPD

Western Montana- Comprehensive System for Personnel Development

Science Standards Training for Trainers

WMPER/ CSPD (WM- CSPD) are sponsoring a Science Standards Training of Trainers for staff interested in providing Training on the new OPI Science standards in the **Region 5** counties: Lincoln, Flathead, Lake, Sanders, Mineral, Missoula, & Ravalli **OR** in the **Region 4** Counties of Beaverhead, Broadwater, Gallatin, Granite, Jefferson, Lewis & Clark, Madison, Park, Meagher, Powell, Silverbow. Participants should be willing to provide training for their own organization as well as be available to provide 1-3 trainings in other districts within Region 4 or 5 upon request within the next 2 years.

Prerequisites:

- Background knowledge, interest and experience teaching inquiry Science
- Interest and ability to teach adults

Content: Trainers will be able to offer Level 1 training that is intended to:

- Identify, explore and develop an awareness and a basic understanding of:
  1. Montana Science Content and Performance Standards
     a. Rationale for revisions
     b. Research supporting revisions
     c. Integration of Indian Education for All (IEFA)
     d. Alignment with state criterion reference test for science (CRT)
  2. Inquiry-based Instruction
     a. Rationale
     b. Research base
     c. Inquiry continuum
     d. Example of inquiry lesson
- Examine selected resources for inquiry-based instruction

Materials: Trainers will be provided with presentation materials and resources to assist in providing this training.

Responsibilities: Participants should be willing to provide training for their own organization as well as be available to provide 2-5 trainings in other districts within Region 4 or 5 upon request over the next 2 years. Compensation may be available for providing training outside your district. Organizations should commit to using these trainers in their district within the next two years.

Stipend: Substitutes or stipend plus mileage will be provided to attend the training in Kalispell or Bozeman

Date/Time/Locations:	**Kalispell**	**Bozeman**
	January 23, 2009 8:30 am to 3:30 pm	February 20, 2009 8:30 am to 3:30 pm
	Linderman Educational Center	Bozeman School District Office, Brd Rm
	125 Third Ave. East Kalispell, MT	2104 W Main Bozeman, MT
Instructors:	Kalispell: Jeff Crews, R 5 Trainer	Bozeman: Katie Burke, OPI

Register at www.cspd.net