A DESCRIPTIVE STUDY OF THE MIDDLE SCHOOL SCIENCE TEACHER BEHAVIOR FOR REQUIRED STUDENT PARTICIPATION IN SCIENCE FAIR COMPETITIONS

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Title: A Descriptive Study of the Middle School Science Teacher Behavior for Required Student Participation in Science Fair Competitions

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This descriptive study explores three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preference for different student-learning modes, and teacher motives for required student participation. Teacher motives for required student participation may stem from curriculum and standardized test requirements, school administrators' expectations, teacher preference for a competitive student-learning mode, and teacher attitudes towards science fair competitions. Survey data collected for this study included teacher attitudes about science fair competitions, teacher preference for different student-learning modes, and demographic data about middle school teachers who sponsor students in PJAS science fair competitions. The theoretical framework in this study is the theory of planned behavior proposed by Ajzen. The results from the analysis of data in this study showed that the majority of the teachers in this sample held positive attitudes towards science fair competitions and required their students to conduct science fair projects but did not require their students to participate in science fair competitions. The middle school science teachers in the sample would involve their students in PJAS competitions even if their districts did not require them to participate. The teachers in this study preferred the cooperative and individualistic student-learning modes. Teacher gender did not influence a preference for a particular student-learning mode. Using the theoretical framework from this study revealed teachers who required their students to participate in science fair competitions also required their students to conduct science fair projects.

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CHAPTER 1

RESEARCH STUDY

Introduction

Science fair competitions can spark a student's interest in science and can increase a student's positive attitudes toward science (Abernathy & Vineyard, 2001; Bruce & Bruce, 2000). In the United States, the majority of students who participated in science fair competitions attended a middle school or junior high school (Abernathy & Vineyard, 2001; Czerniak & Lumpe, 1996). "Students participating in science fairs [competitions] are doing more than learning something new; they are using and extending knowledge gained previously through other experiences" (Balas, 2003, ¶ 3).

The evaluation or judging of student work at a science fair competition can be controversial because a student may not succeed despite quality work (Wang & Yang, 2003). Blenis (2000) noted that science competitions compare students. The National Middle School Association (NMSA) recommends student evaluations that "emphasize individual progress rather than comparison with other students" (National Middle School Association [NMSA], 2003, p. 27). The NMSA's recommendation is noteworthy because the NMSA is "dedicated to improving the educational experiences of young adolescents" (NMSA, 2006, ¶1).

Another controversial aspect of science fair competitions is required student participation. Abernathy and Vineyard (2001), Blenis (2000), Czerniak

(1996), and Czerniak and Lumpe (1996) reported that science teachers required middle and junior high school students to participate in science fair competitions. The National Science Teachers Association (NSTA) advocates only voluntary student participation in competitions (National Science Teachers Association [NSTA], 1999). The NSTA's recommendation about competitions is also noteworthy because the NSTA is "the largest organization in the world committed to promoting excellence and innovation in science teaching and learning for all" (NSTA, 2006, ¶2).

Despite the NMSA's position opposing middle school student involvement in comparative competitions and the NSTA's recommendation denouncing compulsory student participation in competitions, student participation in science fair competitions has increased. The largest science fair in western Pennsylvania, the Pittsburgh Regional Science and Engineering Fair (PRSEF), experienced a 40.0% increase in middle school student participation between 2006 and 2007 and a 10.0% increase in participation between 2008 and 2009 (Kosick, 2009). Due to the increased student participation in science fair competitions and the continued requirement of student participation by middle school science teachers, the teacher behaviors related to student participation in science fair competitions merit further examination.

Statement of the Problem

This descriptive study explores three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preference for different student-learning modes, and the teacher motives for required student participation in science fair competitions. The researcher acknowledged five teacher motives: (1) inclusion of student-conducted experimental science fair projects in the science curriculum, (2) the expectations of school administrators for teachers and students to participate in science fair competitions, (3) the competitive nature of the teacher, (4) skills practiced and knowledge gained by students who participate in science fair competitions, and (5) preparation of students for standardized science assessments.

The theoretical framework for this study is the theory of planned behavior proposed by Icek Ajzen. According to Ajzen (1991), three types of beliefs interact with each other to control human behavior: behavioral beliefs, normative beliefs, and control beliefs. For example, if science teachers possess positive attitudes towards science fair competitions (behavioral belief), prefer a competitive student-learning mode (normative belief), and control their own and their students' participation in science fair competitions (control beliefs and actual behavioral control), the expected teacher behavior would result in required student participation in science fair competitions.

Middle school teachers participated in this study because the majority of students who participated in science fair competitions attended middle and junior high schools (Abernathy & Vineyard, 2001; Czerniak & Lumpe, 1996). Additionally, middle school teachers participated because few of the existing educational research studies discussed teacher behaviors related to student participation in science fair competitions. Abernathy and Vineyard (2001), Bellipanni and Lilly (2003), Blanchard (1989), Blenis (2000), Czerniak (1996), Czerniak and Lumpe (1996), Schneider and Lumpe (1996), Syer and Shore (2001), Wang and Yang (2003), and Yasar and Baker (2003) suggested motives for, or effects of, student participation in science fair competitions but provided no explanation for the teacher behavior of required student participation in science fair competitions. This study explores current gaps in the educational research literature.

Research Questions

Data collected from the questionnaire in this study helps to identify the following relationships between teacher behaviors and student participation in science fair competitions:

1. What is the relationship between middle school science teacher attitudes and student participation in science fair competitions?
2. What is the relationship between middle school science teacher preference for a particular student-learning mode and student participation in science fair competitions?
3. What is the relationship between middle school science teacher motives and student participation in science fair competitions?

Significance of the Study

Competition can cause negative and positive experiences for students who participate. Required participation in science fair competitions may be one cause of negative experiences for students. Abernathy and Vineyard (2001) and Bunderson and Anderson (1996) identified some of the negative experiences for students who participated in science fair competitions as damaging educational consequences from teachers (lower classroom grades), excessive stress from parents, harsh criticism or low scores by judges, and the student's self-imposed stress from wanting to perform well in the competition.

Perseverance by science teachers for required student participation in science fair competitions may result from teacher recognition of the positive experiences available to students who participate. According to Abernathy and Vineyard (2001) and Bunderson and Anderson (1996), positive experiences available for students included assistance with decisions about science careers, recognition of student achievement, student feelings of accomplishment, and the opportunity for students to network with other student scientists. Grote (1996) identified more positive competition experiences for students such as improving student communication skills, learning about other student research projects, and increasing student interest in and enthusiasm for science.

The findings from this study will add to the educational literature about science fair competitions and help pre-service or undecided science teachers formulate an informed opinion about required student participation in science fair competitions. Exploration of the teacher behavior for required student participation in science fair competitions may also reduce the negative competition experiences for students. Most middle school teachers lack the specific training required to meet the educational needs of adolescents (Cooney, 2000; Jackson & Davis, 2000; National Forum to Accelerate Middle Grades Education, 2002; NMSA, 1991). Therefore, middle school science teachers should evaluate their deciding factors for required student participation in science fair competitions.

During the 2007-2008 school years in Pennsylvania, 283,504 students enrolled in the seventh and eighth grades (Pennsylvania Department of Education [PDE], 2008a, 2008b). According to data from the Pennsylvania Junior Academy of Science (PJAS) judging committee, 1,567 middle school students from Pennsylvania participated in the 2008 PJAS state science fair competition (Pennsylvania Junior Academy of Science [PJAS] Judging Committee, 2008). Data from the Pittsburgh Regional Science and Engineering Fair (PRSEF) coordinator showed that 458 middle school students participated in the 2008 PRSEF competition (Kosick, 2009). As a result of at least 2,000 middle school students participating in science fair competitions in Pennsylvania, the teacher behaviors for required student participation in science fair competitions justifies examination.

Definition of Terms

Actual Behavioral Control – The tangible amount of control a person possesses over the execution of a behavior (Ajzen, 1991).

Behavioral Beliefs – The "beliefs about the likely outcomes of the behavior and the evaluations of these outcomes … [these] beliefs produce a person's favorable or unfavorable attitude toward a behavior" (Ajzen, 2002, p. 1).

Control Beliefs – The "beliefs about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors" (Ajzen, 2002, p. 1). The perception of the ability to perform a particular behavior creates these beliefs (Ajzen, 1991, 2002).

Normative Beliefs – The "beliefs about the normative expectations of others and motivation to comply with these expectations" (Ajzen, 2002, p. 1). These beliefs develop from a person's perception of the accepted societal behavior to perform an intended behavior (Ajzen, 1991, 2002).

Theory of Planned Behavior – Behavioral beliefs, normative beliefs, and control beliefs interact to form a behavioral intention. The actual and perceived control over the behavior that a person possesses affects the behavioral intention, which ultimately leads to the performance of the behavior (Ajzen, 1991).

Limitations to the Study

Only middle school science teachers who sponsored students in the PJAS regions 6, 7, 8, 9, and 10 science fair competitions participated in this study. Currently, the PJAS regions 6, 7, 8, 9, and 10 comprise the western half of the Commonwealth of Pennsylvania.

Summary

This descriptive study explores teacher behaviors related to student participation in science fair competitions. To explore these relationships, the data in this study includes middle school science teachers' attitudes about science fair competitions, middle school science teachers' preferences for different student-learning modes, and demographic information about middle school teachers who sponsor students in PJAS science fair competitions. The theoretical framework for this study is the theory of planned behavior.

The next chapter outlines the literature review for this study including a historical perspective of science curricula, an explanation of the theory of planned behavior, teacher attitudes, teacher preferences for different student-learning modes, and motives for the teacher behavior of required student participation in science fair competitions. The literature review concludes with an examination of student science achievement in the United States.

CHAPTER 2

LITERATURE REVIEW

Introduction

This descriptive study explores three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preferences for different student-learning modes, and teacher motives for required student participation in science fair competitions. Middle school science teachers who sponsored students in the PJAS regional science fair competitions from the western half of the Commonwealth of Pennsylvania participated in this study. The literature review begins with a historical review of science curricula followed by the theoretical framework for this study: the theory of planned behavior. The literature review continues with an examination of teacher attitudes, preferences for different student-learning modes, and concludes with a discussion of motives behind the teacher behavior of required student participation in science fair competitions.

Historical Review of Science Curricula

Science curricula have not always been part of the school experience for American students. The following review of science curricula from colonial times to the present day explores the development of the science curricula in public schools in the United States.

Colonial Times

Formal public education of children began in the early 1600s in the colonial schools of Massachusetts and expanded with the centrally controlled town schools of the New England colonies. The Middle colonies educated children with locally controlled parochial and private schools. Wealthier Southern colonial children attended private schools while less economically advantaged students may have attended mission charity schools. The curricula in the colonial, town, private, and charity schools included no science courses but focused on religious reading, writing, arithmetic, manners, and morals (Ornstein & Hunkins, 1998).

Secondary schools began in 1635 with the Latin grammar schools of Boston, MA. Latin grammar schools prepared wealthier male students for acceptance into Harvard or Yale University. The classical curriculum of the Latin schools excluded science courses. Another type of secondary school, the Academy school, opened in the 1700s for students who did not want or could not afford a university level education. The curriculum of the Academy schools also excluded science courses (Ornstein & Hunkins, 1998). Only university students experienced any formal science education in the 1600s and early 1700s (Altenbaugh, 1999; Ornstein & Hunkins, 1998).

Revolutionary War

The end of the Revolutionary War in 1776 brought about changes in school curricula. Educational leaders Benjamin Rush, Benjamin Franklin, Noah

Webster, and Thomas Jefferson stipulated that secondary school curricula should include science courses (Ornstein & Hunkins, 1998; Tolley, 2003). Female students in single gender schools experienced curricula including geography (science) because society expected females to educate future students including their own children. Geography courses evolved into natural philosophy and other science courses such as astronomy, chemistry, botany, and mineralogy. Male students in single gender schools continued to experience curricula with no science courses. Contributing factors for the exclusion of science courses for male students included societal influence for a classical Latin curriculum for males, entrance requirements of universities that mandated students read Latin and Greek, few profitable job opportunities in the scientific fields, and societal resistance to change the classical Latin curriculum (Tolley, 2003).

Harvard University Influence

In 1872, Harvard University required high school physics and other high school science courses for student admission into the university. These changes in admission requirements to Harvard precipitated several changes in the high school curriculum. More science courses were offered in high schools, university professors created new high school science curricula, and more university professors began to write high school science textbooks. In 1887, Harvard University further influenced school curricula in schools with the release of the document, the *Harvard Descriptive List.* This document listed 46 recommended laboratory physics experiments for high school physics courses (Altenbaugh, 1999).

In 1893, Charles Eliot, Harvard University president, chaired the committee responsible for the National Education Association's (NEA) document, *Report of the Committee of Ten on Secondary School Studies.* The committee recommended standardized university requirements for all high school students and an expansion and standardization of the high school curriculum (Atkin & Black, 2007; Kliebard, 1995). The committee also recommended that 25.0% of the high school curriculum contain science courses (Atkin & Black, 2007). As a result of these recommendations, high schools began to incorporate science courses such as astronomy, biology, chemistry, geology, physics, physiology, and zoology into their curricula. By the early 1900s, science education in high schools included semester long science courses in different scientific disciplines (Altenbaugh, 1999).

Great Depression

With the country in economic turmoil, support for science curriculum reform came from various influential sources in the 1930s: the Commission on Secondary School Curriculum, the National Society for the Study of Education (NSSE), the National Education Association's National Committee on Science Teaching, the NSTA, the Harvard Committee on General Education, and the United States Office of Education (Altenbaugh, 1999; Tolley, 2003). One curriculum reform suggested by the NSSE recommended science education in all twelve years of schooling. Another curriculum reform, the Life-Adjustment Education Movement, began in 1944 after the United States Office of Education published the *Vocational Education in the Years Ahead* study (Altenbaugh, 1999). The Life-Adjustment Education Movement changed school curricula to a "practical" curriculum that developed students into productive members of society (Kliebard, 1995; Marshall, Sears, & Schubert, 2000). To create a more practical general education curriculum, schools replaced chemistry and physics courses with biology and general science courses (Tolley, 2003).

Sputnik Era

As the Cold War approached in the 1950s, some educational leaders in the United States considered the practical Life-Adjustment Education Movement curriculum inappropriate. As a result, a more "rigorous" academic curriculum replaced the Life-Adjustment Education Movement curriculum in schools (Marshall et al., 2000). To support the development of rigorous academic curricula, Congress and President Harry S. Truman created the National Science Foundation (NSF) in 1951 (National Science Foundation [NSF], 2005).

After the Soviet Union's successful launch of Sputnik in 1957, the United States panicked about the weakness of science education (Altenbaugh, 1999; Marshall et al., 2000; NSF, 2005; Ornstein & Hunkins, 1998). In response, the National Defense Education Act of 1958 provided government funding to agencies that designed science curricula to improve science education (Altenbaugh, 1999; Kliebard, 1995). The curriculum developers focused on high school science curricula and incorporated the following characteristics: emphasis on pure science, scientific process, and scientific content; depth not breadth of science topics, laboratory-based curriculum centered on a few themes, materials necessary to conduct curriculum, and professional development for teachers (Altenbaugh, 1999). “No other curriculum movement in science so centrally involved the nation’s most accomplished scientists in work at elementary- and secondary-school levels” (Atkin & Black, 2007, p. 791).

Table 1 lists the major science curricula developed with funding from the National Defense Education Act of 1958.

Table 1

Science Curricula Developed with National Defense Act Funds

Level	Acronym	Curriculum Title
High School	PSSC	Physical Science Study Committee
	CHEM	Chemical Education Materials Study
	CBA	Chemical Bond Approach
	BSCS	Biological Science Curriculum Study
Junior High School	IPS	Introductory Physical Science
	SAPA	Science, A Process Approach
Elementary School	ESS	Elementary Science Study
	SCIS	Science Curriculum Improvement Study

Note. From "Curriculum Foundations, Principles, and Issues," by A.C Ornstein, and F.P. Hunkins, 1998, Needham Heights, MA. Copyright 1998 by Allyn and Bacon. From "Historical Dictionary of American Education," by R. J. Altenbaugh, Ed., 1999, Westport, CT. Copyright 1999 by Greenwood Press.

Science curriculum reform continued in the 1970s and 1980s following recommendations by the NSF for science curricula to educate future scientists and society about science. The curricula developed in the 1970s and 1980s differed from the discipline-based curricula of the 1950s and 1960s by integrating science, technology, and society (Altenbaugh, 1999; Hurd, 2000). When the NSTA published *Science-Technology-Society: Science Education for the 1980s;* science, technology, and society (STS) curricula reappeared in school curricula (Berlin & Kumar, 1993).

In 1981, the National Commission on Excellence in Education reviewed the condition of education in the United States. The report created by this group, *A Nation at Risk*, stated that the inability of the United States to compete internationally in economics and education indicated the poor quality of our schools (Beyer, 1985). The Commission made several recommendations for immediate and long-term improvements in education. One recommendation suggested three years of rigorous science courses for all high school students with course content focused on physical science, biological science, scientific inquiry, scientific reasoning, science and society, and environmental implications of science (National Commission on Excellence in Education, 1983a, 1983b; Ornstein & Hunkins, 1998).

Science Standards

In the 1980s, science standards emerged as a major influential factor on science curricula. Two types of standards persevere in education: content standards and performance standards (McLaughlin, Shepard, & O'Day, 1995). A content standard is a "broad description of the knowledge, skills, and understandings that schools should teach and students should acquire in a particular subject area" (McLaughlin et al., 1995, p. 69). Performance standards expand upon content standards by giving "concrete examples and explicit definitions of what students should know and be able to demonstrate proficiency in the skills, knowledge, and understanding framed by the content standards" (McLaughlin et al., 1995, p. 70).

In 1985, the American Association for the Advancement of Science (AAAS) published the first list of science content standards for students in kindergarten through twelfth grade. The AAAS 1989 publication, *Science for All Americans; Project 2061*, listed what all students should know and be able to do in science, math, and technology by high school graduation (American Association for the Advancement of Science [AAAS], 2005). Specific content recommendations by the AAAS for science curricula included "the nature of science, the nature of mathematics, the nature of technology, the physical setting, the living environment, the human organism, human society, the designed world, the mathematical world, historical perspectives, common themes, and habits of mind" (AAAS, 1993, ¶ 3).

In 1991, the National Center on Education and the Economy (NCEE) and the Learning Research and Development Center of the University of Pittsburgh jointly developed performance standards for science education. The New

Standards project created “internationally benchmarked performance standards” (National Center on Education and the Economy [NCEE], 2005, ¶ 1). The New Standards project also developed performance-based assessments and produced portfolio systems to assist schools with standards-based curricula (NCEE, 2005).

In 1993, the AAAS (2006) published the book, *Benchmarks for Science Literacy* that “provided educators with sequences of specific learning goals that they can use to design a core curriculum” (¶ 3). The benchmarks divided the list of standards from *Project 2061* and recommended what students should know and be able to do by the end of 2nd grade, 5th grade, 8th grade, and 12th grade (AAAS, 1993, 2006). The first major alignment of high school science curricula with the AAAS science content standards occurred in 1994. The Scope, Sequence and Coordination Program (SS&C) conducted by the NSTA examined the depth and breadth of high school science curricula (Altenbaugh, 1999). Recommendations by the SS&C program included integration between science disciplines, a spiral curriculum, and science courses every year in middle school and high school. According to the SS&C program, repeated exposure, review, and manipulation of scientific concepts created scientifically literate students (Bybee, 1995).

In 1996, the National Research Council (NRC) published the *National Science Education Standards (NSES)*. Similar to the AAAS benchmarks, the *NSES* promoted science for all students and listed what students in kindergarten through twelfth grade should know and be able to do in science (National Research Council [NRC], 1995). The *NSES* content standards included "unifying concepts and processes in science, science as inquiry, physical science, life science, earth and space science, science and technology, science in personal and social perspectives, [and] history and nature of science" (NRC, 1995, p. 104). The *NSES* also judged the quality of science curricula, science teaching, professional development, science assessments, science education programs, and the science education system. The *NSES* provided a guide for improving student learning of science in all aspects of the educational community (NRC, 1995).

The next major influence on science curricula occurred in 2001. The No Child Left Behind (NCLB) Act of 2001 mandated nationwide science curriculum reform. Specifically for science curricula, the NCLB Act required every state to adopt science content standards and to coordinate standardized science assessments for all students in elementary school, middle school, and high school by the 2007 to 2008 school year (George, 2002). In 2002, the Pennsylvania Department of Education (PDE) adopted and published state content standards for general science, technology, environmental science, and ecology. The Pennsylvania state standards listed the scientific concepts and skills that students in all school districts in Pennsylvania should know and be able to perform by 3rd grade, 7th grade, and 11th grade (PDE, 2006).

Global and national political events have shaped and continue to shape science curricula in the schools of the United States. In the 1940s, 1950s, and 1960s, national science education reform focused on secondary level science education, but by the 1970s, 1980s, and 1990s, state science education reform had expanded to focus on all levels of science education (Bybee, 1995). National and state science standards and the No Child Left Behind Act of 2001 are the major influential factors on the science curricula currently experienced by students in the United States (Bybee, 1995; George, 2002).

Theoretical Framework

Theory of Planned Behavior

This section of the literature review explains the theory of planned behavior proposed by Icek Ajzen. According to the theory, three types of beliefs interact to form a behavioral intention: the attitudes towards the behavior (behavioral beliefs), the social pressure to perform the behavior (normative beliefs), and the perceived ease of performing the behavior (control beliefs). In order for the behavioral intention to become an overt behavior, the person performing the behavior must control the execution of the behavior. Actual control over the behavior influences the behavioral intention, the perceived behavioral control beliefs, and the behavior. As the attitudes towards the behavior and social pressure to perform the behavior positively increase, the perceived ease of performing the behavior also increases. Past experiences or information obtained from other sources about the ease of behavior performance also influences behavioral control (Ajzen, 1991, 2002).

Applying the theory of planned behavior to this study, the middle school science teacher behavior of required student participation in science fair competitions can be explained. For example, if middle school science teachers possessed positive attitudes towards science fair competitions (behavioral belief), preferred a competitive student-learning mode (normative belief) in their classrooms, and controlled their own and their students' participation in science fair competitions (control belief and actual behavioral control), then the predicted behavioral intention and resulting behavior of these teachers would be required student participation in science fair competitions. Figure 1 illustrates the theory of planned behavior proposed by Ajzen.

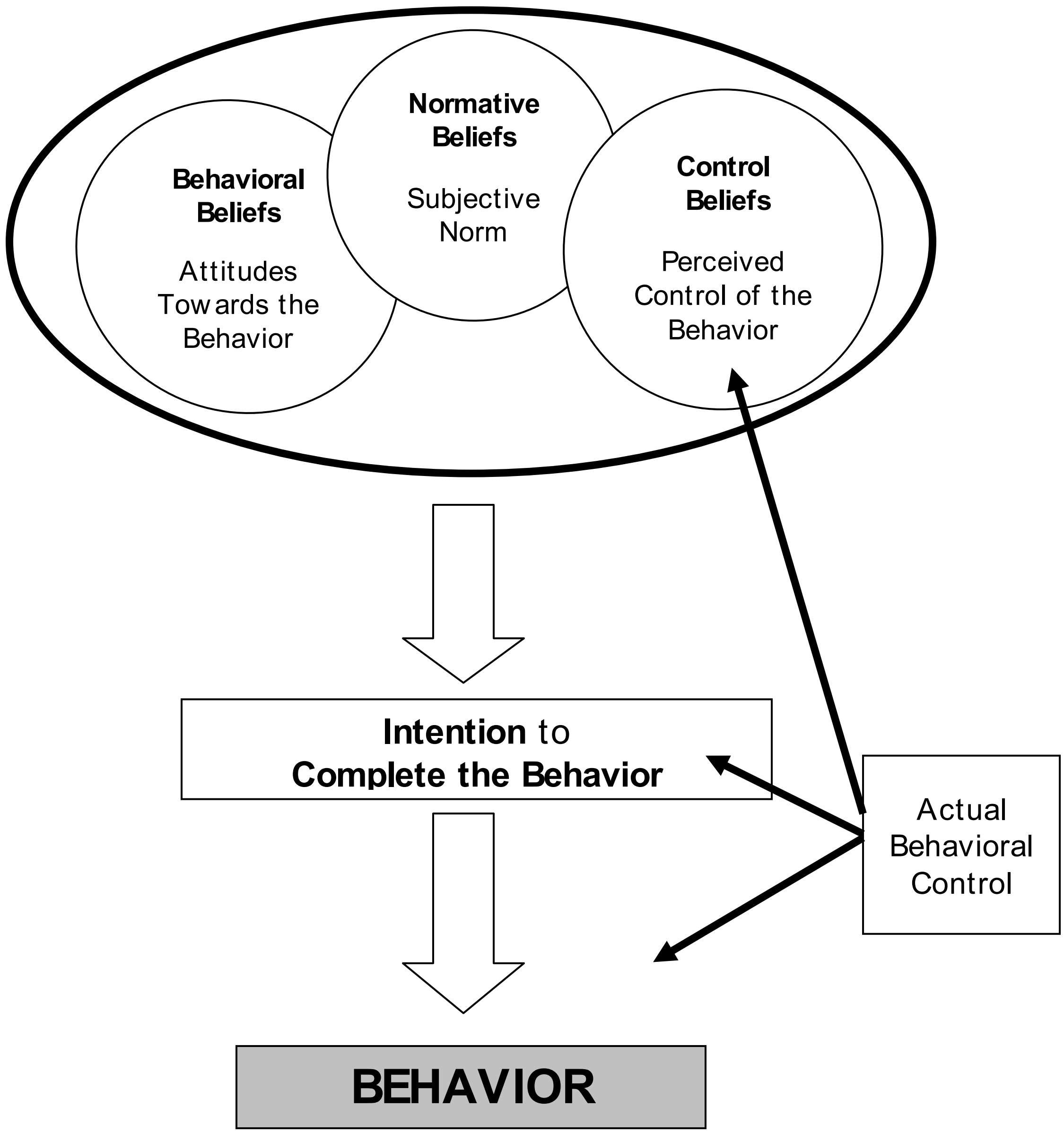


Figure 1. Visual representation of the theory of planned behavior.[1]

[1] From "Constructing a TpB questionnaire: Conceptual and methodological considerations", by I. Ajzen, 2002, Retrieved December 30, 2003 from http://www-unix.oit.umass.edu/~ aizen/publications.html. Copyright 2006 by Icek Ajzen. Adapted with permission of the author.

Science Teacher Attitudes

This section of the literature review explores science teacher attitudes and their influence on the teacher behavior of required student participation in science fair competitions. Effects of teacher attitudes on the classroom emerged in a study by Jones and Carter (2007). Attitudes of teachers influenced pedagogy, classroom management, curriculum selections, choice of assessments in the classroom, and interactions with students (Jones & Carter, 2007). Results from a study by Wilson (2006) showed that teacher attitudes towards students impacted student performance. Teacher concern for students influenced student motivation, student grades, and student attitudes towards the class (Wilson, 2006). These sources suggested that teacher attitudes about science fair projects may result in the science teacher behavior of required student participation in science fair competitions.

Goals of Science Education

Teacher attitudes about the ability of student-conducted experimental science fair projects to allow students to experience the goals of science education may result in the science teacher behavior of required student participation in science fair competitions. Students who conducted experimental science fair projects merged scientific knowledge with scientific skills, reasoning, and critical thinking to construct an understanding of science (NRC, 1995). A student-conducted experimental science fair project duplicated the scientific world for students and contributed to student learning in science by providing students with an opportunity to conduct scientific research using the scientific method and inquiry learning (Bellipanni & Lilly, 2003; NSTA, 1999).

Schneider and Lumpe (1996) surveyed science teachers who sponsored students in science fair competitions to explore teacher attitudes about the ability of experimental science fair projects to meet the goals of science education. The teachers in the study rated student-conducted science fair projects positively and reported that experimental science fair projects incorporated hands-on science, promoted scientific knowledge, modeled scientific inquiry, and integrated higher order thinking skills (Schneider & Lumpe, 1996). Grote (1995b) also surveyed science teachers about their attitudes towards student-conducted experimental science fair projects. The majority of the teachers in the study agreed that experimental science fair projects were valuable tools for student learning and "provide lessons that could not be duplicated by classroom instruction" (Grote 1995b, p. 274).

Standardized Science Assessments

Teacher attitudes about the ability of student-conducted experimental science fair projects to allow students to practice skills assessed on standardized science assessments may result in the science teacher behavior of required student participation in science fair competitions. Standardized science assessments occur at the international, national, and state level in the United States. Table 2 lists the international assessments of students from the United States.

Table 2

International Science Assessments

Year	Assessment	Acronym	Participants	
1969	First International Science Study	FISS	10-year-old, 14-year-old, and students in their final year of school	24 countries
1983 to 1986	Second International Science Study	SISS	10-year-old, 14-year-old, and students in their final year of school	9 countries separated into 13-17 systems
1988	First International Assessment of Educational Progress	IAEP-1	13-year-old students	6 countries separated into 12 systems
1990 and 1991	Second International Assessment of Educational Progress	IAEP-2	9-year–old and 13-year-old students	20 countries
1995	Third International Mathematics and Science Study	TIMSS	4th-grade, 8th-grade, and students in their final year of school	41 nations
1999	Third International Mathematics and Science Study-Repeat	TIMSS-R	8th-grade students	38 nations
2003	Trends in International Mathematics and Science Study	TIMSS	4th-grade and 8th-grade students	38 nations
2006	Program for International Student Assessment	PISA	15-year-old students	57 countries
2007	Trends in International Mathematics and Science Study	TIMSS	4th-grade and 8th-grade students	36 countries and 48 countries

Note. From "Highlights from PISA 2006: Performance of U.S. 15-year-old students in science and mathematics literacy in an international context," by S. Baldi, Y. Jin. M. Skemer, P.J.

Green, P.J., and D. Herget, 2007, Washington, DC: NCES. From "Highlights from TIMSS-R." by P. Gonzales, L. Calsyn, L. Jocelyn, K. Mak, D. Kastberg, S. Arafeh, T. Williams, & W.Tsen, 2000, Washington, DC: U.S. Government Printing Office. From "Highlights From TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth and Eighth Grade Students in an International Context," by P. Gonzales, T. Williams, L. Jocelyn, S. Roey, D. Kastberg, & S. Brenwald, 2008, Washington, DC: U.S. Government Printing Office. From "Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003," by P. Gonzales, J.C. Guzman, L. Partelow, E. Pahike, L. Jocelyn, D. Kastberg, & T. Williams, 2004, Washington, DC: U.S. Government Printing Office. From "International mathematics and science assessment: What have we learned?" by E.A. Medrich & J.E. Griffith, 1992, Washington, DC: U.S. Government Printing Office. From "*The IEA st*udy of science II: Science achievement in twenty-three countries," 1992, by T. N. Postlethwaite, & D.E. Wiley, (Eds.), Oxford: Pergamon Press. From "The IEA study of science I: Science education and curricula in twenty-three countries," 1991, by M.J Rosier, & J.P. Keeves, (Eds.), Oxford: Pergamon Press.

On the FISS, SISS, 1995 TIMSS, 1999 TIMSS-R, 2003 TIMSS, and 2007 TIMSS, fourth grade or 10-year-old students from the United States consistently scored above the international average for science achievement (Gonzales, Guzman, Partelow, Pahike, Jocelyn, Kastberg, & Williams, 2004; Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008; Medrich & Griffith, 1992). TIMSS data for students from the United States ranked fourth grade student science achievement at its highest level on the 1995 TIMSS, decreasing to a lower level of achievement on the 1999 TIMSS-R, and remaining at that lower level of achievement on the 2003 and 2007 TIMSS. Overall, the science achievement for fourth grade students has changed slightly since the 1995 TIMSS (Gonzales, Guzman et al., 2004; Gonzales, Williams et al., 2008).

Eighth grade or 14-year-old students experienced international assessments most often. On the FISS and the SISS, eighth grade students scored at international levels for science achievement. On the IAEP-1 and IAEP-2, eighth grade students scored below international levels for science achievement and on the 1995 TIMSS, 1999 TIMSS-R, 2003 TIMSS, and 2007 TIMSS eighth grade students scored at or above international levels for science achievement (Gonzales, Calsyn, Jocelyn, Mak, Kastberg, Arafeh, Williams, & Tsen, 2000; Gonzales, Williams et al., 2008; Mead, 1994; Medrich & Griffith, 1992). TIMSS data showed eighth grade student science achievement changed very little between the 1995 TIMSS and 1999 TIMSS-R and increased to its highest level on the 2003 and 2007 TIMSS (Gonzales, Guzman et al., 2004; Gonzales, Williams et al., 2008). Additionally, eighth grade students from the United States scored below the international average in science literacy for 15-year-old students on the PISA assessment (Baldi, Jin, Skemer, Green, & Herget, 2007).

Students in their final year of school, or 12th-grade students from the United States, experienced international assessments the least of all student groups tested. These students consistently scored below international average levels for science achievement on the FISS, the SISS, and the 1995 TIMSS (Gonzales, Guzman et al., 2004; Medrich & Griffith, 1992). The fact that students from the United States enrolled in fewer higher-level science courses than their international student counterparts contributed to the lack of science achievement by 12th-grade students in the United States (Calsyn, Gonzales, & Frase, 1999).

At the national level, the National Assessment of Educational Progress (NAEP), also known as the *Nation's Report Card,* assessed the "condition and progress of education" (National Center for Education Statistics [NCES], 2006, p. 1). Data from the NAEP assessments indicated the national level of achievement for 4th-grade, 8th-grade, and 12th-grade students in public and private schools in the United States (Lee & Paik, 2000; NCES, 2006). According to the 2005 NAEP data, fourth grade students increased in science achievement levels between 2000 and 2005. Eighth grade students showed no changes in science achievement levels and 12th-grade students decreased in science achievement levels between 2000 and 2005 (Grigg, Lauko, & Brockway, 2006). In 2009, the NCES repeated the NAEP science assessment but no results on student science achievement have been published (NCES, 2009).

At the state level, the NCLB Act of 2001 required every state to coordinate standardized science assessments for all students in elementary school, middle school, and high school by the 2007 to 2008 school year (George, 2002). Results of the 2008 Pennsylvania state science assessment showed 82.5% of 4th-grade students achieved advanced or proficient levels in science achievement, 52.7% of 8th-grade students achieved advanced or proficient levels in science achievement, and 35.7% of 11th-grade students in Pennsylvania public schools achieved advanced or proficient levels in science achievement (PDE, 2009).

Science Achievement Gap

Teacher attitudes about the ability of student-conducted experimental science fair projects to lessen the science achievement gap for minority ethnic-racial student groups in the United States may result in the science teacher behavior of required student participation in science fair competitions. Researchers searched for influential factors for the science achievement gap with data from the National Educational Longitudinal Study (NELS: 88) and data from the international math and science studies (Bacharach, Baumeister, & Furr, 2003; Baldi, et al., 2007; Gonzales, Calsyn et al., 2000; Gonzales, Guzman et al., 2004; Gonzales, Williams et al., 2008; Muller, Stage, & Kinzie, 2001; Singh, Granville, & Dika, 2002). Factors contributing to student science achievement included student attitudes toward science, amount of student motivation, socioeconomic status (SES), racial-ethnic group, and gender (Bacharach et al., 2003; Muller et al., 2001; Singh et al., 2002).

A positive attitude by students towards science, the amount of academic class time, and the amount of student motivation in science showed the greatest positive effect on student achievement. Motivated students were those students who prepared for science class (had books, pencil, and paper) and who completed homework (Singh et al., 2002). Motivated students who lacked cognitive ability performed better than unmotivated students with greater cognitive ability (Hurd, 2000).

A difference in science achievement existed among racial-ethnic student groups and this achievement difference increased throughout high school for all groups. Students from all racial-ethnic groups increased in science achievement by 12th grade, but all groups increased at different rates and started at different levels of science achievement. The African American student group showed the lowest increase in science achievement between 8th and 12th grades (Bacharach et al., 2003; Muller et al., 2001). On the 2007 TIMSS, the White student group narrowly outperformed the Asian student group. Both student groups consistently outperformed the multiracial student group and the Hispanic student group which consistently outperformed the African American student group in science achievement (Gonzales, Williams et al., 2008).

Results from the PISA and the NAEP mirrored the differences in science achievement on the TIMSS by different racial-ethnic student groups. On the 2006 PISA, the White student group scored highest in scientific literacy and the African American student group scored lowest in scientific literacy. The Hispanic student group scored higher than the African American student group but lower than the Asian student group (Baldi, et al., 2007). Comparing the 2000 and the 2005 NAEP data, the science achievement gap narrowed among all minority student groups in fourth grade but remained the same among eighth grade student groups. In 12th grade, a widening of the achievement gap occurred between the White student group and the African American student group (Grigg, et al., 2006).

Gender also influenced student science achievement (DeBacker & Nelson, 2000; Dimitrov, 1999; Lupart, Cannon, & Telfer, 2004; Muller et al., 2001; Shakeshaft, 1995). Female students in every racial-ethnic group in the Muller et al. (2001) study scored lower in science achievement than their male student counterparts. In elementary school, male and female students exhibited equivalent levels of achievement, of participation, and interest in science (Dimitrov, 1999; Shakeshaft, 1995). On the 2007 TIMMS, fourth grade male and female students showed no measurable difference in science achievement scores (Gonzales, Williams et al., 2008). As students progressed into middle school and then high school, female students exhibited a continued decrease in interest, participation, achievement, and perceived science ability (DeBacker & Nelson, 2000; Dimitrov, 1999; Lupart et al., 2004; Shakeshaft, 1995). On the 2007 TIMSS, eighth grade male students scored higher in science achievement than eighth grade female students (Gonzales, Williams et al., 2008). Asian American male students showed the highest increase in science achievement between 8th grade and 12th grade (Bacharach et al., 2003; Muller et al., 2001).

The science achievement gap widened between male and female students during high school. Female students enrolled in fewer science courses in high school resulting in fewer female students entering into science and engineering career tracks at the university level (DeBacker & Nelson, 2000; Lupart et al., 2004). A study by Miller, Blessing, and Schwartz (2006) examined gender differences in the attitudes toward science scientists, and science careers of 79 high school students. Results from the study showed higher interest by female students for humanities courses over most science courses. Female students majoring in science did so because of the health related field (medicine, pharmacy, nursing, etc.) they wished to pursue. *Low interest not low ability* contributed to the lack of female students in high school science classes (Miller, et al., 2006).

The SES of students strongly and positively correlated to eighth grade science achievement for gender and race-ethnicity. The Latina student group showed the strongest correlation between SES and science achievement of all student groups studied followed by the African American female student group and the African American male student group (Muller et al., 2001). The SES achievement gap continued in high school for students because male and female students from a lower SES did not complete higher-level science courses (Kennedy & Parks, 2000).

Teachers can narrow the science achievement gap for race-ethnicity, gender, and SES through better curricular planning for students in these groups. Teachers can encourage and enable students to improve their science achievement through student participation in exemplary science courses. The more science courses completed by students: the higher their science achievement (Muller et al., 2001). Adding aspects of biology and humanitarianism to all science courses increased female student interest in science courses (Miller et al., 2006). "Incorporating humanitarianism in science courses may reduce the rejection of science courses by girls by de-masculinzing the subject (i.e. removing competition, mechanical views of nature, and activities without context)" (Baker & Leary, 1995. p. 3). Prudent science curricular choices for students may alleviate or narrow the science achievement gap because students who valued science and held positive attitudes regarding science performed well on science assessments (DeBacker & Nelson, 2000; Singh et al., 2002). Other factors that influenced science achievement such as student motivation and the amount of academic class time in science can also be addressed by educators to help narrow the science achievement gap for all targeted student groups (Singh et al., 2002).

According to Kahle, Parker, Rennie, and Riley (1993) the most influential factors for the gender achievement gap included teacher expectations, different teacher classroom interactions with students, and the type of pedagogy employed by the teacher in the classroom. Consequently, teachers can narrow the gender science achievement gap by implementing the following recommendations from Kennedy and Parks (2000):

> (a) interest females in science early in education, (b) encourage parental support of females in science, (c) include females in the science curriculum, (d) improve pre-service teacher science knowledge,

(e) provide female role models, (f) provide female educators in science classes at the middle school & high school levels, (g) consider single sex classrooms. (p.276)

Student-Learning Modes

Teacher preference for a competitive student-learning mode in the science classroom may result in the science teacher behavior of required student participation in science fair competitions. In a survey study of teachers from the United States, male teachers preferred the competitive student-learning mode with male math and science teachers showing the strongest preference for the competitive student-learning mode in their classrooms (Owens, 1985). Science teachers, through their choice of pedagogy, determine the learning mode exposed to the students in their classroom. "Teachers have been socialized through their long years as students, and through this socialization may have developed beliefs about classroom organization" (Trumball, Scarano, & Bonney, 2006, p. 1718). Teachers who prefer a competitive student-learning mode may provide more competitive pedagogy in their classrooms.

In a study by Johnson (2006) about learning-style preferences of 214 grade 5 students from various racial-ethnic groups and different geographical areas showed that male students had a significant preference for the individualistic student-learning mode. Additionally, Owens (1985) reported that male students preferred the competitive and individualistic learning modes in the classroom. In a study by Johnson (2006), all student groups surveyed in the study preferred cooperative learning to the other student-learning modes. “In the classroom, no teacher can take into account all of the learning preferences of each individual student, however… teachers can make their approach a more comprehensive one that includes diverse preferences [for student-learning modes]” (Johnson, 2006, p. 514).

Competitions

If science teachers required their students to participate in science fair competitions, then those teachers should be aware of the factors that afford competition success for students, the negative and positive student competition experiences, and the science fair competitions currently available to students. The research studies discussed in this section of the literature review pertain to science fair competitions at regional, state, national, or international levels. Few research studies have been conducted on classroom, school, or district level science fair competitions (Yasar & Baker, 2003). A caveat to this research information is that science fair competitions typically involved students who were “high achiever[s], competitive, and successful” (Yasar & Baker, 2003, p. 4). Regardless, the success factors identified by high achieving students can be applied to all students who participate in science fair competitions.

Wiygul and Gifford (1987) suggested that all students might not “have an equal and fair chance of winning in science fair competitions” (p. 117). Success factors for students who participated in science fair competitions included parental pressure for the student to participate in the competition, student confidence in scientific endeavors, teacher evaluation of the science fair project, the judge's score of the student's science fair project becoming a classroom grade, the use of university facilities, and the amount of money spent on the science fair project (Czerniak, 1996; Jackson, 1995; Wiygul & Gifford, 1987). Additionally, Abernathy and Vineyard (2001), Bellipanni (1994), Bunderson and Anderson (1996), Czerniak (1996), Jackson (1995), and Olsen (1985) identified resources in the form of support from teachers, librarians, or parents as the factor that best predicted student success in science fair competitions. Students who received no support while completing a science fair project resorted to cheating behaviors such as fabricating data, copying another's work, or having someone else complete parts of their science fair project. According to Shore and Delcourt (1995) and Syer and Shore (2001), 25.0% of the students who participated in science fair competitions resorted to cheating behaviors.

Gender may also play a role in student success in science fair competitions. A significant difference existed in preferences for competition according to gender. Female students ranked competing against other students as a 10th place reward for participating in science fair competitions; whereas, male students ranked competing against other students as a 3rd place reward (Abernathy & Vineyard, 2001). Male students may prefer competitions more than female students prefer competitions leading to a higher success rate for male students in competitions (Benenson, Roy, Waite, Goldbaum, Linders, & Simpson, 2002).

Student participants in science fair competitions may encounter negative experiences such as damaging educational consequences from teachers (lower classroom grades), excessive stress from parents, harsh criticism or low scores by judges, and self-imposed stress by students who want to perform well in the competition (Abernathy & Vineyard, 2001; Bunderson & Anderson, 1996). The NSTA (1999) provided the following recommendations to reduce the negative student experiences associated with science fair competitions:

1. Student and staff participation in science competitions should be voluntary and open to all students.
2. Emphasis should be placed on the learning experience rather than on the competition.
3. Science competitions should supplement and enhance other educational experiences and be closely aligned or integrated with the curriculum.
4. Projects and presentations must be the work of the student with proper credit to others for their contributions.
5. Scientific competitions should foster partnerships between students, the school and the science community. (NSTA, 1999, ¶2)

Not all science fair experiences for students were negative. Student participants also experienced positive competition experiences including positive student recognition, student feelings of accomplishment, help for students in personal decisions regarding science careers, and the opportunity to network with other students and scientists (Bunderson & Anderson, 1996). Other advantages for students who participated in science fair competitions included practice and improvement of communication skills, encouragement of scientific interest and enthusiasm, the opportunity to network with other student scientists, learning new scientific information and an increased interest in science (Abernathy & Vineyard, 2001; Bruce & Bruce, 2000; Czerniak & Lumpe, 1996; Grote, 1995a, 1995b).

The adults in the lives of students directly influenced positive science fair competition experiences for students. Czerniak and Lumpe (1996) surveyed students who participated in science fair competitions about their attitudes toward science fair competitions and their perceptions of the people who approved of their participation in the competition. Students surveyed possessed positive attitudes towards science fair competitions and reported that teachers and parents most approved of their participation in the science fair competition (Czerniak & Lumpe, 1996).

Required student participation may be viewed by students as a negative competition experience but science teachers may have a different view. Blenis (2000) placed fifth grade students into two groups: mandatory and voluntary participation. Only *five* of the 99 fifth grade students placed in the voluntary group completed a science fair project (Blenis, 2000). The limited voluntary participation by students in science fair competitions may be attributed to: the numerous negative experiences associated with science fair competitions, the amount of out of school work necessary to complete a science fair project, and the lack of time students have to prepare for a science fair competition (Yasar & Baker, 2003). According to Blenis (2000), “it appears that for students to benefit from the inquiry-oriented, hands-on approach of science fairs, they [science fair competitions] must be made mandatory” (p. 21).

Syer and Shore (2001) and Abernathy and Vineyard (2001) also recommended mandatory student participation in science fair competitions. Syer and Shore (2001) additionally recommended that students selected project topics familiar to them and that adults provided students with support to complete the project and manage time. Adolescents required external incentives to participate in science fair competitions because adolescents typically experience a decline in motivation. Positive first-time experiences in science fair competitions could promote voluntary student participation in successive science fair competitions (Abernathy & Vineyard, 2001).To increase student participation in competitions, science teachers needed to serve as role models, coaches, and vocal supporters of science fair competitions (Blenis, 2000). “Competition alone cannot make learners function beyond their maximum ability unless they have help, such as a coach, mentor, or advisor” (Van Eck, 2006, p. 168).

Competition Opportunities

Currently, six national science fair competitions exist for students: the International Science and Engineering Fair (ISEF), the Junior Academy of

Science (JAS), the Junior Science and Humanities Symposia (JSHS), the Science Talent Search, Siemens Competition in Math, Science and Technology, and the Society for Science & the Public (SSP) Middle School Program. The ISEF boasts the longest history of all science fair competitions currently available to students. The progression to the current ISEF began in New York City when the American Museum of Natural History created a science fair competition called the American Institute Children's Science Fair (The New-York Historical Society, 2002; Silverman, 1986). At the first American Institute Children's Science Fair, students of all ages from schools within a 55-mile radius of Times Square in New York City exhibited research projects (Adams, 1967). In 1938, organizers renamed the fair to the Junior Science Fair. Supported by the American Museum of Natural History, the Junior Science Fair continued as a local yearly event and in 1939 organizers again renamed the fair to the Science and Engineering Fair (The New-York Historical Society, 2002).

Watson Davis, former editor of *Science News* and the director of Science Service, initiated the evolution of the Science and Engineering Fair in New York City to a national science fair event. Davis and the American Institute developed the Science Clubs of America in 1941. Initially, about 800 science clubs organized and gradually, as interest and partnerships with other organizations grew, more than 25,000 science clubs enrolled 600,000 students. The different Science Clubs of America conducted local and regional science fair competitions. In 1950, student winners from these local and regional Science

Clubs of America science fairs attended the first national science fair competition in Philadelphia, Pennsylvania, sponsored by the Franklin Institute and the Science Service (Science Service, 2003). This first national science fair gathered 30 high school students who competed for $1,000 in prize money in two separate competitions: one for male students and another for female students (Intel, 2005).

The national science fair competition continued yearly in different cities throughout the United States and welcomed the first international competitors in 1959 (Intel, 2005). Student participation in the national science fair increased yearly and in 1964 the national science fair officially became an international science fair when organizers changed the name of the competition to the International Science and Engineering Fair (Bellipanni & Lilly, 2003; Science Service, 2003). Students who competed in the national ISEF competition initially placed in an ISEF-affiliated state science fair. Every ISEF-affiliated state fair sends two student projects and one team project to the ISEF (Science Service, 2006b).

At the ISEF or an ISEF-affiliated state competition, students present their research to judges using a poster display. Judges interview students and students may have at most 10 interviews with judges (Intel, 2006b). Judges score student research on a scale from 0 to 100 points using the following categories: creative ability (30 points), scientific thought or engineering goals (30 points), thoroughness (15 points), skill (15 points), and clarity (10 points)

(Intel, 2006c). In 2008, 1,557 high school students participated in the 59th annual ISEF, the largest number of participants on record. The top three student finalists (all three female) from the 2008 ISEF each received a $50,000 scholarship and other prizes (Intel, 2008).

The JAS organization began in the early 1930s when the AAAS created the National Junior Academy of Science (PJAS Region 7, 2005). The JAS encourages junior and senior high school students to conduct scientific research. At a JAS competition, students present a 10 minute oral presentation to a panel of judges. After the presentation, the judges conduct a 5 minute question and answer session with each student. Judges evaluate the student work and award a first, second, or third place. Students receiving a first place award at the regional competition attend the state competition, present their research again, and compete for another placing award (PJAS, 2003). Presently, the Senior Academy of Science in every state sponsors a state chapter of the JAS. The Pennsylvania JAS organization began in March 1934 when the Pennsylvania Senior Academy of Science created a committee to develop the PJAS. The first PJAS student competition occurred in Reading, Pennsylvania (PJAS Region 7, 2005). Currently, the PJAS organization provides competition opportunities for students with 12 regional science fair competitions and one state science fair competition yearly in Pennsylvania.

The JSHS program is a state, national, and international science fair competition exclusively for high school students. Since the 1960s, the Army, Navy, and Air Force branches of the Armed Services have sponsored the program. The JSHS program encourages students to conduct scientific research, searches for talented youth in science and mathematics, strives to increase the number of adults who will be able to conduct scientific research, and provides research opportunities for students in government, academic, and industrial areas. To compete in one of the 48 university-sponsored state JSHS competitions, students submit research papers detailing their scientific research. Accepted student participants each present a 12 minute oral presentation to a panel of judges after which judges conduct a 6 minute intensive question and answer session with the student. The judges critique the student research paper and oral presentation. Judges award category winners and then the category winners compete against each other to determine the place winners in the competition. Students who receive the top awards from each of the JSHS state competitions participate in the national JSHS competition. Top student winners in the national competition have the opportunity to compete in the international JSHS competition (Junior Science and Humanities Symposium [JSHS], 2004).

The Science Talent Search began in 1942 through the combined efforts of the Science Service and the Westinghouse Electric Company. The Science Talent Search competition requires high school student researchers to complete an application, write a research report, acquire teacher recommendations and high school transcripts, and then send all the information to Science Service for review (Science Service, 2003). The Science Service judges the received information and chooses 40 student finalists to present their scientific research at the Science Talent Search Institute in Washington, DC. Student competitors present their research, network with other student scientists, meet with scientists, and visit historic and cultural sites. During the Science Talent Search competition, student finalists compete for more than $500 million in scholarships (Science Service, 2006a).

For the Siemens Competition in Math, Science and Technology, each high school student provides an abstract and research paper to Siemens. The judges select 300 projects as semi-finalists. From the list of 300 semi-finalists the judges further select at least 30 individual and group projects to compete in one of six regional competitions conducted at partner universities. The partner universities include the Massachusetts Institute of Technology, Carnegie Mellon University, Georgia Institute of Technology, University of Notre Dame, University of Texas at Austin, and Stanford University. Regional student finalists present their research to a panel of judges with a poster display and a 12 minute oral presentation. After each presentation, the judges conduct an intensive question and answer session with the student. Winners of the regional competition attend the national competition in New York City to compete for prizes (Siemens Corporation, 2005).

The SSP Middle School Program, a national science fair competition specifically for fifth, sixth, seventh and eighth grade students, evaluates applications from middle school students nominated by the ISEF science fair coordinators. From the applications, judges select 40 student finalists to compete in a national competition in Washington, DC. Student finalists complete in group activities to judge their problem solving, communication, and leadership abilities. Students present their research to a panel of judges with a poster display. Judges determine student winners from a combined score received from oral presentations (30.0%) and group activities (70.0%) (Society for Science and the Public [SSP], 2008).

Additional Teacher Motives

Science teacher motives for required student participation in science fair competitions may additionally result from expectations by school administrators for middle school science teachers and students to participate in science fair competitions and from the nature of the middle school teachers who sponsor students in science fair competitions. The majority of students who participated in science fair competitions attended a middle school or junior high school (Abernathy & Vineyard, 2001; Czerniak & Lumpe, 1996). As a result, this section of the literature review explores middle school curricula and middle school teachers.

School District Expectations

School administrators may expect teachers and students to participate in science fair competitions and that expectation may manifest as science fair projects being included in the science curriculum or by the type of teacher assigned to teach at the middle grade level. Middle school may be the best time to introduce students to science fair projects and competitions. High school teachers surveyed by Grote (1995b) believed that science fairs were "most appropriate at the junior high level" (p. 276). Also, middle school is an important time for school districts concerning science achievement of students because several international, national, and state science assessments occur during middle school (Gonzales, Guzman et al., 2004; McLeod, D'Amico, & Protheroe, 2003; NCES, 2006). Student-conducted experimental science fair projects may be one way to increase student science achievement.

Middle School Curricula

The best middle school curricula incorporated middle school philosophy, best educational practices in teaching adolescents, and workforce skills. The workforce skills that allowed students to be competitive in the job force included solving problems, using current technology, applying higher order thinking skills, and accessing and processing information (Hurd, 2000). Best educational practices included academic rigor, equity, and developmental appropriateness for adolescents. Academic rigor expressed clear learning goals, included reasoning processes, and provided methods to evaluate the content in the curriculum. Equity allowed all learners from all ability and racial-ethnic groups to achieve and to extend their knowledge in a content area. Equity promoted high achievement and provided a variety of opportunities for all students to show achievement while considering the different learning rates of different students. Developmental appropriateness focused on content quality and activities in the curriculum (Berns, Kantrov, Pasquale, Mankang, Zubrowski, Goldsmith et al., 2003). The NMSA identified the following characteristics of exemplary middle school curricula: “challenging, integrative and exploratory, varied teaching and learning approaches, assessment and evaluation that promotes learning, flexible organizational structures, programs and policies that foster health, wellness, and safety, and comprehensive guidance and support services” (NMSA, 2003, p.13).

The NMSA also recognized specific intellectual developmental characteristics of the middle school student. A student-conducted experimental science fair project can meet the intellectual developmental characteristics of an adolescent. Table 3 matches the intellectual characteristics of middle school students with science fair projects.

Table 3

Adolescent Characteristics Matched to a Science Fair Project

Intellectual Developmental Adolescent Characteristics[a]	Experimental Science Fair Project
Display a wide range of individual intellectual development	Project topics and difficulty can match different students' abilities
Are intensely curious and have a wide range of intellectual pursuits, few of which are sustained	Project topics are chosen by students to help sustain motivation
Prefer active over passive learning experiences	Students actively collect data
Prefer interaction with peers during the learning activities	Students interact with other student scientists
May show disinterest in conventional academic subjects but are intellectually curious about the world and themselves	Unconventional project topics help to foster curiosity in students

Note. [a] From "This We Believe: Successful Schools for Young Adolescents", by National Middle School Association, 2003, Westerville, OH: Author, p. 43-51. Copyright 2003 by the National Middle School Association.

Additionally, integration of the science fair project among the different disciplines in the middle school curriculum provided middle school students with expertise from several teachers to help students successfully complete the science fair project. According to Vars (1997), an integrated curriculum allowed teachers to show connections among disciplines, reduced duplication in assignments, and encouraged teaching of skills and content across the curriculum. Also, an integrated curriculum improved student motivation, helped students to transfer knowledge to new situations, and allowed students to compile knowledge from other classes in a meaningful way (Lee, 2007).

In 2001, the Center for Science Education profiled commercially available exemplary science curricula. All curricula identified by the Center for Science Education shared the following characteristics: opportunity for scientific inquiry, structured sequence of activities to support and review student learning of scientific concepts, assessments that tested higher-level thinking skills, and integration of science content, skills, and processes (Berns et al., 2003). Table 4 lists the names of the curricula, the appropriate grade levels for implementation, and the science domains explored with each science curricula.

Table 4

Exemplary Science Curricula Identified by the Center for Science Education

Curriculum Name	Grades	Science Domains
ARIES: Astronomy-Based Physical science	3-8	Earth Science and Physical Science
BSCS: Middle School Science and Technology	6-8 or 7-9	Earth Science, Life Science and Physical Science
EBS: Events-Based Science	5-9	Integrated Science, Earth Science, Life Science and Physical Science
FAST: Foundational Approaches in Science Teaching	6-10	Physical Science, Earth and Space Science, and Life Science
FACETS: Foundational and Challenges to Encourage Technology-Based Science	6-8	Earth Science, Life Science and Physical Science
FOSS/MS: Full Option Science System for Middle School	6-8	Earth and Space Science, Life Science, and Physical Science
Investigating Earth Systems	5-8	Earth Science
MITS: Models in Technology and Science	5-9	Physical Science and Technology
STC/MS: Science and Technology Concepts for Middle Schools	7-8	Life Science, Earth Science, Physical Science and Technological Design
SEPUP: Science Education for Public Understanding Program	8-9	Earth Science, Life Science and Physical Science
SALI: Science and Life Issues	6-8	Life Science
SEPUP Modules	6-12	Earth Science, Life Science and Physical Science

Note. From "Guiding Curriculum Decisions for Middle-Grades Science Abridged and Updated: A Quick Reference Guide for Educators", by B.B. Berns et al., 2003, Newton, MA. Copyright 2003 by the Education Development Center, Inc.

Middle School Teachers

Abernathy and Vineyard (2001), Blenis (2000), Czerniak (1996), and Czerniak and Lumpe (1996) reported that science teachers required their middle and junior high school students to participate in science fair competitions. In the middle schools of the 2000s, women (89.0%) predominately staffed the schools and 18.0% of the women acquired middle level certifications, 52.0% secondary certifications, and 30.0% elementary certifications. A survey of middle school principals by Petzko (2002) revealed that 77.0% of the principals expressed concern about the lack of knowledge by middle level teachers about interdisciplinary instruction, developmentally appropriate practices and assessments, and adolescent behaviors and problems. As of 2002, only 41.0% of the states required a middle school teacher to obtain a middle level certification (Gaskill, 2002). When not required, specialized preparation programs were unlikely to be completed by teachers and unlikely to be supported by educational institutions (McEwin, Dickinson, Erb, and Scales, 1995). "Only when middle grades licensure becomes universally required will young adolescents be assured of having teachers who have received the specialized preparation needed to serve them well" (McEwin et al., 1995, p. 5).

The NMSA "strongly supports the specialized professional preparation of middle level teachers both at the pre-service and graduate levels" (NMSA, 2006, p. 5). The NMSA (2006) identified the following essential elements for a middle level teacher preparation program: content area knowledge, adolescent development, pedagogy, assessment, middle level philosophy, organization, curricula planning, and field experiences. Reiterating and expanding on the list from the NMSA, Jackson and Davis (2000) recommended middle school teachers receive preparation in the following areas:

> (a) a strong grasp of subject matter and the use of assessments, (b) pedagogical knowledge and skills grounded in an understanding of human development and learning theories, (c) an understanding of interdisciplinary teaming, (d) an understanding of young adolescents' developmental characteristics and needs, (e) an understanding of the school's governance system, (f) skills to support a safe and healthy school environment, (g) the capacity to engage parents and community members. (p. 96)

Additionally, Jackson and Davis (2000) stated that an effective middle school teacher demonstrated familiarity with interdisciplinary teaming and adolescent development.

In 2002, Congress enacted the NCLB Act of 2001. One provision of the NCLB Act of 2001 required all core academic subject teachers to be "highly qualified" by the end of the 2006 school year. Highly qualified teachers possessed a full state certification or passed a state teacher-licensing exam for their subject taught. The highly qualified requirements in the NCLB Act of 2001 greatly impacted teachers at the middle school level. The NCLB Act of 2001 considered all elementary certified teachers employed by middle schools “unqualified”. These middle school teachers had several options: pass a state teacher-licensing exam for the content area taught, obtain a secondary certification, or transfer to an elementary school (National Association of Elementary School Principals [NAESP] & National Association of Secondary School Principal [NASSP], 2003). In 2003, the NMSA reiterated the need for highly successful middle school teacher preparation programs to properly prepare educators to teach in middle schools (NMSA, 2003). Hines and McMahon (2005) demonstrated that need in their study of pre-service teachers when the pre-service teachers could not clearly interpret middle school students’ understanding of a specific math reasoning strategy. The pre-service teachers in the study were ill-prepared to discern the developmental cognitive growth of an adolescent (Hines & McMahon, 2005).

Summary

This descriptive study explores three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preferences for different student-learning modes, and the teacher motives behind the behavior of required student participation in science fair competitions. Most students who participated in science fair competitions were middle school students (Abernathy & Vineyard, 2001; Czerniak & Lumpe, 1996). Therefore, this study focused on middle school teachers and their behavior of required student participation in science fair competitions.

If conducted properly, experimental science fair projects and student participation in science fair competitions can be part of an exemplary middle school science curriculum. The science fair process can provide students with academic rigor, model workplace skills, help provide equity by addressing the science achievement gap, and can include practices that are developmentally appropriate for adolescents. Keeping middle school students involved in activities with adult mentors, such as science fair competitions, may be one way to help reduce the risky behaviors exhibited by some adolescents (Hurd, 2000). Student-conducted experimental science fair projects may also be the great equalizer for gender in science achievement as shown at the 2005 and 2008 ISEF, where the top three winners were female students from the United States (Intel, 2006a, 2008).

As Blenis (2000) noted, students did not voluntarily conduct a science fair project. Science teachers needed to require student participation in experimental science fair projects, especially for female students and students from racial-ethnic and low socioeconomic groups. If teachers utilize the factors from educational research that are proven to help students succeed in completing a science fair project and competing in science fair competitions (i.e. teacher, parental, and monetary support), then student-conducted experimental science fair projects and science fair competitions can be useful tools to increase science achievement for all student groups.

CHAPTER 3

METHODOLOGY

Introduction

This descriptive study explores three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preferences for different student-learning modes, and the teacher motives for required student participation in science fair competitions. Middle and junior high school students participated in most science fair competitions in the United States, and these students were required by their science teachers to participate in the competitions (Abernathy & Vineyard, 2001; Blenis, 2000; Czerniak, 1996; Czerniak & Lumpe, 1996). By exploring this teacher behavior, the results from this study will add to the educational literature about science fair competitions and will help teachers who have not decided about required student participation in science fair competitions formulate an informed opinion.

This descriptive study utilized a questionnaire to (a) identify middle school science teacher attitudes regarding the merit of student participation in science fair competitions, (b) determine teacher preferences for, and evaluation of, three different student-learning modes in the classroom, and (c) compile teacher demographic information that may influence teacher behavior. The researcher created the demographic part of the questionnaire and compiled the Science Fair survey and Learning Style Preference – Teachers (LPST) survey part to complete the questionnaire. Middle school teachers, rather than students, participated in this study because the existing educational research studies did not review the science teacher's role in science fair competitions. This study explores the gap in the educational research literature.

Analyses of the data collected from the questionnaire in this study explored the following research questions:

1. What is the relationship between middle school science teacher attitudes and student participation in science fair competitions?
2. What is the relationship between middle school science teacher preference for a particular student-learning mode and student participation in science fair competitions?
3. What is the relationship between middle school science teacher motives and student participation in science fair competitions?

The Participants

Middle school teachers from parochial, private, and public schools in rural, urban, and suburban locations in western Pennsylvania participated in this study. All study participants sponsored students in PJAS regional science fair competitions in 2005. The ages of participants in this study ranged from 22 to 65: the current age range of employees in Pennsylvania school districts (PDE, 2005). Teachers who participated in this study included men and women because no restriction to gender existed. Also, participants in this study included no vulnerable subjects, received no compensation, and experienced no known potential risks.

Of the 101 questionnaires distributed to middle school teachers at the different PJAS regional competitions, teachers completed 60 questionnaires. The sample in this study included 60 middle school science teachers from western Pennsylvania who sponsored students in one of the PJAS regional 6, 7, 8, 9, or 10 science fair competitions during 2005. The researcher created sub-groups in the sample according to teacher attitudes toward science fair competitions and teacher preferences for one of the three different student-learning modes in the classroom.

The Setting

Currently, PJAS regions 6, 7, 8, 9, and 10 encompass all counties in the western half of the Commonwealth of Pennsylvania. Table 5 lists the PJAS region, the science fair competition date, the site for the PJAS science fair competition, and the location by county of the Pennsylvania schools invited to each PJAS science fair competition. On the scheduled competition dates, the researcher attended each of the PJAS regional science fair competitions listed in Table 5. Two of the PJAS competitions occurred on the same date; consequently, the researcher attended the PJAS region 8 competition at 8:00 a.m. and the PJAS region 9 competition at 1:00 p.m.

Table 5

2005 PJAS Regional Competitions in Western Pennsylvania

Region	Competition date	Competition location	Counties of invited schools	
6	March 5, 2005	Penn State Altoona Altoona, Pennsylvania	Bedford Cambria Clearfield	Blair Centre Huntingdon
7	February 5, 2005	Chartiers Valley High School Pittsburgh, Pennsylvania	Allegheny Westmoreland	
8	February 26, 2005	California University California, Pennsylvania	Crawford Fulton Venago	Fayette Somerset Warren
9	February 26, 2005	Slippery Rock University Slippery Rock, Pennsylvania	Armstrong Butler Indiana Washington	Beaver Greene Jefferson
10	February 19, 2005	Gannon University Erie, Pennsylvania	Cameron Elk Forest McKean Potter	Clarion Erie Lawrence Mercer

Note. From "Short History of the Pennsylvania Junior Academy of Science," by Pennsylvania Junior Academy of Science, 2003, Retrieved November 30, 2005, from http://pjas.net/pjas_info.php?PHPSESSID= 7f8d60d9fae0b7963131afa0b98565df. Copyright 2003 by the PJAS.

Each science teacher who attended a PJAS regional competition served as a PJAS judge and returned to a central location after viewing student presentations to complete judging forms. PJAS competition organizers called this central location the “judging room”. After teachers completed their PJAS judging responsibilities, the researcher distributed an informed consent form, a voluntary consent form, and a questionnaire to every middle school teacher in the judging room. The researcher verbally instructed the teachers to read the informed consent form and complete the voluntary consent form if they chose to participate in this study. The researcher also answered all questions from the teachers concerning the consent forms or questionnaire.

Teachers completed the consent forms and the questionnaire in the judging room and deposited their questionnaire into a deposit box near the entrance to the judging room. Additional copies of the informed consent form were available near the deposit box. The researcher placed a sign above the surplus consent forms located near the deposit box that informed teachers to take an additional copy of the informed consent form. Teachers who chose not to participate in this study deposited their uncompleted questionnaires in the same deposit box as those teachers who completed the questionnaire.

Testing Instrument

Middle school teachers who participated in this study completed a 15 minute written questionnaire that combined three different data collection components:

- A 16-question demographic information survey that collected data about the teacher, the teacher's students who participated in science fair competitions and the teacher's school district (see Appendix F for demographic information survey).
- A 13-statement Science Fair survey with a 4-response Likert scale that quantified teacher attitudes towards science fair competitions (see Appendix G for Science Fair survey).
- A 33-statement LPST survey with a 4-response Likert scale that identified teacher preferences for and evaluation of three different student-learning modes in the teacher's classroom (see Appendix H for LPST survey).

Demographic Information Survey

The researcher created the demographic information survey component of the questionnaire for this study by reviewing examples of demographic surveys from other research studies and by including suggestions from the researcher's dissertation committee. The demographic information survey contained 16 questions designed to gather information about middle school science teachers including: school type, gender, race, career issues, monetary compensation for participation in PJAS, competition requirements imposed by school districts, and other requirements imposed by teachers for student participation in PJAS science fair competitions.

Science Fair Survey

The Science Fair survey component of the questionnaire evolved from a survey created for a study conducted by Dr. Michael Grote in 1995. Grote surveyed secondary science teachers (n= 191) to determine teacher opinions about science fair projects and science fair competitions. The researcher reviewed the validity, reliability, and sample of the Grote study. Data collected by Grote quantified teacher attitudes about science fair competitions, suggesting validity of the statements in the survey. Data collected in the Grote study showed no significant difference when one group of data was expanded to include the same group nationally. The lack of a statistically significant difference between the local and national data groups suggested reliability of the Grote Science Fair survey. The sample from the Grote study resembled the sample from this research study as both samples included science teachers from parochial, private, and public schools in rural, urban and suburban areas (Grote, 1995a).

The researcher deemed the Science Fair survey appropriate for this study with a few modifications. Permission to use and to modify the Grote Science Fair survey was requested and received from the author via email (see Appendix A for permission email). Modifications to the Grote survey included a 4-category Likert scale, one rephrased statement, one added statement, and eight removed statements (see Appendix G for the Science Fair survey used in this study). The modified Likert scale in the Science Fair survey removed the "no opinion" choice and required teachers to rank their attitudes towards each statement on the Science Fair survey as: strongly agree, moderately agree, moderately disagree, or strongly disagree. An additional benefit with the modified Likert scale was the similarity to the 4-category Likert scale on the LPST survey part of the questionnaire in this study.

The researcher rephrased statement #1 from the 1995 Grote survey for clarity; therefore, the words "outdated idea" replaced the word "anachronism". The added statement, "If my district did not require participation, I would not involve my students in science fair competitions", helped to identify science teacher attitudes toward voluntary teacher involvement in science fair competitions. The researcher removed eight statements from the 1995 Grote survey because the content of the statements did not reflect the purpose of this study. The final version of the revised Science Fair survey contained 13 statements and asked teachers to use a 4-category Likert scale to quantify their attitudes toward science fair competitions.

Learning Preference Scale–Teachers Survey

The LPST survey component of the questionnaire in this study required no modifications from the LPST survey utilized in a 1985 research study conducted by Dr. Lee Owens of the University of Sydney, Australia. Owens surveyed teachers (n= 336) from various schools in Minneapolis, Minnesota, to identify teacher preference for and evaluation of three different student-learning modes (Owens, 1985). On the LPST survey, teachers identified if each of the

33 statements on the LPST survey were true, "sort of true", "sort of false", or false (Owens & Barnes, 1992).

The researcher reviewed the validity, reliability, and sample of the LPST survey to justify using the survey in this study. Previous data collected with the LPST survey identified teacher preferences for student-learning modes suggesting validity of the statements in the survey. Cronbach's alpha measures the consistency of a data set. The Cronbach's alpha values for the middle school teachers from the United States data set ranged from .60 to .79, which suggested reliability because these alpha values were the highest values obtained for any of the teacher subscales (Owens & Barnes, 1992).

Forty percent of the sample from the Owens (1985) study included middle school teachers from public schools. Forty-three percent of the sample in this study included middle school teachers from public schools; therefore, the sample from the Owens study and this study were similar. The researcher purchased the LPST survey via the internet from the Australia Council for Educational Research (ACER) (see Appendix B for purchase receipt and Appendix H for the LPST survey).

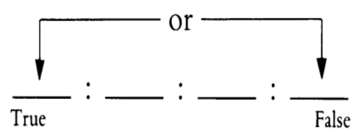
Procedure for Data Collection

Questionnaire Construction

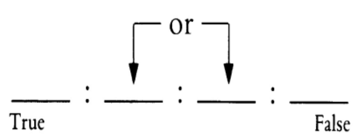
The instrument in this study was a questionnaire containing three surveys. The researcher created the demographic information survey, modified the Science Fair survey from the 1995 Grote study, and purchased the LPST survey from ACER. The directions provided with the LPST survey served as the model for the directions to the Science Fair survey because both surveys utilized a 4-category Likert rating scale. The directions from the LPST survey required no modifications and were copied into the questionnaire in their entirety (see Figure 2).

DIRECTIONS: Each of these 33 items is a statement that a teacher has made about learning. You will note some similarities in the way items are written. Despite this, each item actually refers to a *different* aspect of learning in the classroom. Please respond to each one independently.

There are no right or wrong answers. If the statement is clearly true for you, check the *space at the* **True** *end* of the answer line. If it is clearly false for you, check the *space at the* **False** *end* of the answer line.



If it is a bit more true than false ('sort of true'), check the *inner space at the True end*; if it is a bit more false than true ('sort of false'), check the *inner space at the False end.*



For a number of statements it may be possible to say 'well, it all depends on . . .'. Please go past that reaction to an opinion that seems true for you most of the time. Answer each item — leave no blanks.

Figure 2. Directions and Likert scale from the LPST survey.[2]

[2]From "Learning Preference Scales: Handbook and Test Master Set," by L. Owens and J. Barnes, 1992, p. 1. Copyright 1992 by the Australian Council for Educational Research (ACER). Reprinted with permission of the author.

Consent

The Indiana University of Pennsylvania School of Graduate Studies and Research provided guidelines for completion of the informed consent form (see Appendix D for form) and the voluntary consent form (see Appendix E for form). The researcher stapled the informed consent form and the voluntary consent form together and then distributed both consent forms to the study participants for completion. The consent forms were separate from the questionnaire distributed in this study.

Site Permission

This study required site permission from the PJAS organization because the participants in this study attended different PJAS regional science fair competitions. Prior to the PJAS fall state director's meeting in 2004, where site permission was requested by the researcher, no contact or information about this study was shared with members of PJAS, including the PJAS state director and PJAS regional directors, with myself being the exception for PJAS regional directors. The state and regional directors of PJAS had no influence over participants in this study because all data collected remained anonymous and confidential.

A request to conduct this study was added to the agenda of the PJAS fall state director's meeting scheduled for October 1, 2004, at University Park, Pennsylvania. At the fall director's meeting, the researcher informed members of the PJAS organization about this study and permission was granted by the regional directors to conduct this study at the 2005 PJAS region 6, 7, 8, 9, and 10 competitions. The researcher asked the PJAS regional directors to show no influence towards any teachers who chose to participate or not participate in the study. The state director of PJAS also granted permission to conduct this study, and the state secretary of PJAS documented the site permission in the minutes of the meeting (see Appendix C for site permission).

Data Collection

Before the scheduled data collection days for this study, the researcher submitted an IRB protocol that was approved by the Indiana University of Pennsylvania. The researcher created two deposit boxes for the questionnaires using empty standard size photocopy paper boxes with slots cut into the lids. The researcher also posted a sign to remind participants to take an additional copy of the informed consent form for their records (see Appendix I for reminder sign).

The researcher stored the completed questionnaires in a large fireproof, secure safe located in the researcher's residence at 156 Fisanick Lane, Nicktown, Pennsylvania. Data from the questionnaires were confidential. In accordance with APA guidelines, the researcher will maintain all data for five years after the date of project completion at which time the data will be destroyed. The researcher will email an executive report of the results to all PJAS directors, to all teachers who participated in the study, to the developer of the LPST survey (Dr. Lee C. Owens), and to the developer of the Science Fair survey (Dr. Michael Grote).

Data Analysis

Demographic Information Survey Data

Frequencies and valid percentages were calculated for results to all questions on the demographic information survey. A total score representing teacher choice to sponsor students in a PJAS science fair competition was calculated using teacher responses to questions #8, #12, and #13 on the demographic information survey. A "yes" response for questions #8 and #13 and a "no" response for question #12 received a score of one point each. The opposite response to these questions received a score of two points each. Points were tallied and reported as the Teacher Self-Control total score. A total score of three points represented teachers who had total control over their choice to sponsor students. A total score of four or five points represented teachers who had some control and a total score of six points represented teachers who had no control over their choice to sponsor students in a PJAS science fair competition.

A score representing teacher control over student completion of science fair projects was calculated using teacher responses to question #10 on the demographic information survey. A "yes (all students)" response for question #10 received a score of one point. A "yes (only students who choose to participate)" response received a score of two points and a "no" response to question #10 received a score of three points. Scores were reported as the Teacher Student-Control A total score. An additional total score representing teacher control over student participation in a PJAS science fair competition was calculated in the same manner with question #11 on the demographic information survey. Scores were reported as the Teacher Student-Control B total score. Lower total scores represented more teacher-control and higher total scores represented more student-control over completion of a science fair project and participation in science fair competitions.

Science Fair Survey Data

Valid percentages, means, standard deviations, and item analyses were calculated for teacher responses to each of the Science Fair survey statements. Item analyses showed the number of teachers who strongly agreed, moderately agreed, moderately disagreed, and strongly disagreed with each statement on the Science Fair survey.

A total score representing teacher attitudes towards science fair competitions was calculated by scoring the 4-category Likert scale responses on the Science Fair survey. Responses to statements #1, #2, #5, #8, #12, and #13 on the survey received a score of one point for the response "strongly agree", a score of two points for the response "moderately agree", a score of three points for the response "moderately disagree", and a score of four points for the response "strongly disagree". Responses to statements #3, #4, #6, #7, #9, #10, and #11 on the survey received the reverse scoring. Scores were tallied and reported as the Teacher Attitude total score. Statements #2 and #12 were eventually eliminated from the total score because the answers to these statements were determined by the researcher to be indirect measurements of attitudes towards science fair competitions. A total score of 44 points on the survey reflected completely positive teacher attitudes towards science fair competitions. A total score of 11 points on the survey reflected completely negative teacher attitudes towards science fair competitions.

The researcher ranked Teacher Attitude total scores in descending order for the entire sample. The Teacher Attitude groups were identified by utilizing a matrix of possible total scores if all 11 statements on the Science Fair survey were answered with each possible value (4 points, 3 points, 2 points, and 1 point). The matrix, created by this fictional scoring, identified for the researcher when the total score represented more 4 point answers than 3 point answers and so on. The highest possible total score (44), the lowest possible total score (11), and the total score if all questions were answered with 2.5 points (27.5) identified range points in the highest, lowest, and middle groups. The researcher determined the other group score ranges by looking at the matrix. Table 6 shows the score ranges for the groups of Teacher Attitude total scores and further explains the total scores included in each group.

Table 6

Score Ranges for Teacher Attitude Total Scores Groups

Teacher Attitude Gradient	Group	Range of Total Score	Explanation
Strongest Positive Attitude	1	39-44	More 4-point answers than 3-point answers make up the total score
	2	31-38	Remaining total scores
Neutral Attitude	3	25-30	Contains midpoint total score and total scores with eight 3-point answers and three 2-point answers and vice versa
	4	17-24	Remaining total scores
Strongest Negative Attitude	5	11-16	More 1-point answers than 2-point answers make up the total score

Group 1 represents teachers with the highest possible positive attitudes towards science fair competitions. Group 2 represents teachers with mostly positive attitudes towards science fair competitions. Group 3 represents teachers possessing positive and negative attitudes towards science fair competitions. Group 4 contains teachers possessing more negative than positive attitudes towards science fair competitions and group 5 represents teachers with negative attitudes towards science fair competitions. Teacher Attitude total score groups were also compared with the demographic data to determine any relationships, specifically, if teacher attitudes influenced the teacher behavior for required student participation in science fair competitions.

Learning Preference Scale -Teachers Survey Data

Frequencies and valid percentages for the teacher responses to each of the LPST survey statements were calculated. The researcher further analyzed data from the LPST survey for each teacher using the personal feedback form (see Appendix J for form) from the *Learning Preference Scale Handbook and Test Master Set* (Owens & Barnes, 1992). Each statement on the LPST survey received a score of four, three, two, or one based on the respective response of the teacher: true, "sort of true", "sort of false", and false. All responses received this scoring except responses to statements #4, #6, #15, #17, #25, and #27 which the researcher scored in the reverse direction. If a teacher did not respond to a statement, the researcher recorded a score of 2.5 for that statement as instructed by the survey developers (Owens & Barnes, 1992). The researcher defined an unfinished survey as one statement not being completed by the teacher. All unfinished surveys were destroyed via shredding and the data discarded.

Using the personal feedback form, the researcher calculated a Teacher Preference raw score for every teacher for each category of classroom student-learning mode (cooperative, competitive, and individualistic). Raw scores were then converted into percentile scores using the reference group data from the Owens study with teachers from the United States (see Appendix K for reference group data). Percentile scores represented the strength of a teacher's preference for each student-learning mode relative to a comparable group.

Percentile scores allowed comparison among the categories with the highest percentile score representing the preferred student-learning mode of the teacher. The highest percentile score for a teacher placed that teacher into the appropriate Teacher Preference Category group: cooperative, competitive, or individualistic. If two student-learning mode percentile scores were equivalent for a teacher, then the data from that survey were analyzed in both categories (Owens & Barnes, 1992).

Data from the groups were also compared with the demographic data and the Science Fair survey data in order to uncover any relationships. Analysis of the Teacher Preference Category data with the demographic data showed the impact of teacher preferences for a particular student-learning mode on the teacher behavior of requiring students to participate in science fair competitions. Analysis of the Teacher Preference Category data with the Teacher Attitude data showed the impact of teacher preferences for a particular student-learning mode on teacher attitudes towards science fair competitions.

Comparison of Multiple Survey Data from Questionnaire

Based on the teachers' preferred student-learning mode category (cooperative, competitive, individualistic) identified by the LPST survey, the researcher categorized the data collected from the Science Fair survey and the demographic information survey. The researcher used the category data and calculated Pearson correlations and two binary logistical regressions. The Pearson correlation determined relationships between the teachers' preferred student-learning mode and their attitudes towards science fair competitions. This correlation explored the extent to which the competitive nature of the teachers impacted their behavior for required student participation in science fair competitions.

The binary logistic regressions determined if the data predicted the science teacher behavior of required student participation in science fair competitions. The first binary logistic regression determined if data from the study predicted the teacher response to demographic question #11 which asked teachers if they required students to compete in science fair competitions. The Teacher Attitude total score data (behavioral beliefs) from the Science Fair survey, the Teacher Preferences category data (normative beliefs) from the LPST survey, and the Teacher Self-Control score groupings (control beliefs) from demographic questions #8, #12, and #13 were combined for the first logistic regression.

The second binary logistic regression determined if the outcome to demographic question #10 could be predicted by teacher attitudes towards science fair competitions represented by the Teacher Attitude total score (behavioral beliefs) groupings from the Science Fair survey, by the Teacher Preferences for a student-learning mode (normative beliefs) category from the LPST survey, and by the Teacher Student-Control A score (control beliefs) from demographic question #10. The second binary logistic regression required the use of the logit transform equation for proper interpretation of the results. The logit transform equation utilized was $\text{Log}\ (\pi/1-\pi) = \beta_0 + \beta_1 * x$.

Additionally, descriptive statistics were calculated for the demographic data compared with the LPST survey category data and the Science Fair survey groupings data. Table 7 summarizes all data analyses from this study.

Table 7

All Data Analyses from Questionnaire

	Demographic Information Survey	Science Fair Survey (SFS)	Learning Preference Scale – Teachers (LPST) Survey
Descriptive Statistics	• Frequencies • Valid Percentages	• Item Analysis • Valid Percentages • Mean • Standard Deviation	• Frequencies • Valid Percentages
Individual Survey Analyses	• Teacher Self-Control total score Questions #8, #12, & #13 - sponsoring students • Teacher Student-Control A score Question #10 - student completion of science fair projects • Teacher Student-Control B score Question #11 - student participation	• Teacher Attitude score • Teacher Attitude score groups Positive Neutral/Negative	• Teacher Preference raw score for a particular student-learning mode • Teacher Preference Category Cooperative Competitive Individualistic
Analyses of Combined Survey Data	Descriptive Statistics • SFS Teacher Attitude total score and demographic data • LPST Survey Teacher Preference Category with demographic data Pearson Correlation • LPST Survey Teacher Preference Category with SFS Teacher Attitude scores Two different Binary Logistic Regression Analyses Demographic information survey Teacher Self-Control score OR Teacher Student-Control A score, SFS Teacher Total Attitude score, and LPST Teacher Preference for Student-Learning Mode Category groups		

Summary

The questionnaire in this descriptive study quantified teacher attitudes about science fair competitions, identified teacher preferences for one of three different student-learning modes, and gathered demographic information about the middle school science teachers who sponsored students in PJAS science fair competitions. The entire data set was analyzed using descriptive statistics. Data were subsequently grouped for teacher attitudes towards science fair competitions and teacher preferences for a particular student-learning mode. Grouped data were analyzed with the demographic data, Pearson correlations, and two different binary logistic regressions.

The data analyses confirmed effects of teacher attitudes and teacher preferences for a particular student-learning mode on the behavior of required student participation in science fair competitions. Several proposed motives influenced teacher attitudes and behaviors towards student completion of science fair projects and student participation in competitions. The data also supported the theoretical framework of this study and predicted the middle school science teacher behavior of required student participation in science fair competitions. The next chapter shows the analysis of the data collected in this study.

CHAPTER 4

RESULTS

Introduction

This descriptive study explored three aspects of teacher behavior related to student participation in science fair competitions: teacher attitudes, teacher preferences for different student-learning modes, and teacher motives for required student participation in science fair competitions. Participants in this study completed a questionnaire that included a Science Fair survey to quantify teacher attitudes toward science fair competitions, a LPST survey to identify teacher preferences for a competitive, cooperative, or individualistic student-learning mode, and a demographic information survey.

Analyzed data answered the following research questions:

1. What is the relationship between middle school science teacher attitudes and student participation in science fair competitions?
2. What is the relationship between middle school science teacher preferences for a particular student-learning mode and student participation in science fair competitions?
3. What is the relationship between middle school science teacher motives and student participation in science fair competitions?

The researcher traveled to five different PJAS regional science fair competitions in 2005 and surveyed middle school science teachers who sponsored students in the PJAS science fair competitions. The anonymous participants in the study were voluntary. Data from the three components of the questionnaire were analyzed separately and then specific data from the questionnaire were analyzed to identify any correlations and any variables that were significant predictors for the teacher behavior of required student participation in science fair competitions.

Demographic Information Survey Data

Participants answered 16 different questions pertaining to the teacher and to the science fair competitions on the demographic information survey. Data from each question were analyzed for frequencies and percentages. Table 8 shows the distribution of the demographic data for the first three questions on the survey that identified middle school science teachers' school type, gender, and race.

Table 8

Demographic Information Survey Questions #1, #2, and #3

Question #	Information	Survey Choices	Frequency	Percentage
1	School Type	Public	26	43.3
		Private	34	56.7
		Total	60	100.0
2	Teacher Gender	Male	14	23.3
		Female	46	76.7
		Total	60	100.0
3	Teacher Race	White	57	95.0
		Hispanic	3	5.0
		Asian	0	0.0
		African American	0	0.0
		Latino/Latina	0	0.0
		Other	0	0.0
		Total	60	100.0

All teachers answered questions #1, #2, and #3 on the demographic survey. According to the data, most teachers who had students participate in the PJAS science fair competitions were employed by private schools (56.7%), female (76.7%), and white (95.0%). Public school teachers accounted for 43.3% of the sample surveyed, male teachers accounted for 23.3% of the sample, and Hispanic teachers accounted for the remaining 5.0% of the sample. No Asian, African American, or Latino teachers sponsored students in any of the PJAS regional 6, 7, 8, 9, and 10 competitions in this study.

Question #4 on the demographic information survey categorized the teaching experience of the sample in this study. Table 9 lists the frequencies and percentages of the data for question #4.

Table 9

Demographic Information Survey Question #4

Question #	Information	Survey Choices	Frequency	Percentage
4	Total Years Teaching	1-5 years	9	15.0
		6-10 years	5	8.3
		10-15 years	10	16.7
		15-20 years	11	18.3
		20-25 years	9	15.0
		25-30 years	8	13.3
		Over 30	8	13.3
		Total	60	100.0

The percentages for total years teaching experience showed a varied sample with participants who have teaching experience in all survey choices. The greatest percentage (18.3%) of teachers occurred in the 15 to 20 years category and the lowest percentage (13.3%) of teachers occurred with the 6 to 10 years category of teaching experience. All teachers in this study answered this question on the demographic information survey.

While the range of teaching experience for the sample in this study was distributed over several different categories, the distribution of teaching experience in science content for this sample was not, as shown in Table 10.

Table 10

Demographic Information Survey Question #5

Question #	Information	Survey Choices	Frequency	Percentage
5	Total Years Teaching	1-5 years	16	27.1
		6-10 years	5	8.5
		10-15 years	10	16.9
		15-20 years	14	23.7
		20-25 years	6	10.2
		25-30 years	4	6.8
		over 30 years	4	6.8
		Total	59	100.0
		Missing	1	
		Total	60	

Teachers with 1 to 5 years of science-teaching experience populated the highest percentage (27.1%) of the sample in this study. Teachers with 15 to 20 years of science teaching experience were the second most populous group (23.7%). The least amount of sample participants had science-teaching experience in the 25 to 30 years category (6.8%) and in the over 30 years category (6.8%). One participant in the sample did not answer question #5 on the survey.

Data to categorize the grade levels of science-teaching experience of the sample were achieved with question #6 on the demographic information survey. Teachers who currently teach or have taught middle school students created the largest portion of the sample (91.7%). Science-teaching experience at the elementary level was true for 25.0% of the sample and science-teaching experience at the high school level was true for 23.3% of the sample in this study. Only one participant (1.7%) in this study taught science at the post-secondary level. Table 11 lists the categorized results of demographic survey question #6.

Table 11

Demographic Information Survey Question #6

Question #	Information	Type	Survey Choices	Frequency	Percentage
6	Grade Levels Teaching Science	Elementary	Yes	15	25.0
			No	45	75.0
			Total	60	100.0
		Middle School	Yes	55	91.7
			No	5	8.3
			Total	60	100.0
		High School	Yes	14	23.3
			No	46	76.7
			Total	60	100.0
		Post Secondary	Yes	1	1.7
			No	59	98.3
			Total	60	100.0

Question #7 on the demographic information survey grouped the number of years of experience together for teachers who sponsored students in the PJAS competitions from the western half of Pennsylvania. Table 12 lists the distribution for demographic question #7.

Table 12

Demographic Information Survey Question #7

Question #	Information	Survey Choices	Frequency	Percentage
7	Teacher Participation in PJAS	1-5 years	22	36.7
		6-10 years	13	21.7
		10-15 years	7	11.7
		15-20 years	11	18.3
		20-25 years	3	5.0
		25-30 years	4	6.7
		Total	60	100.0

All participants in this study answered demographic question #7. Teachers who participated in PJAS for 1 to 5 years comprised the largest portion (36.7%) of the sample. The number of teachers who continued to sponsor students in PJAS competitions appears to dwindle after 20 years of sponsoring students in PJAS competitions.

A possible motive to explain the science teacher behavior of required student participation in science fair competitions may be due to the amount of control the teacher possesses over self-participation and student participation in science fair competitions. Demographic information questions #8, #12, and #13 were analyzed together because those questions determined if the teachers voluntarily sponsored PJAS students. Question #8 and question #13 each had one study participant who did not answer the question. The majority of teachers in this sample were voluntarily participating in PJAS science fair competitions (86.4%), were not required by their school districts to participate in PJAS (78.3%), and indicated that they volunteered to be a sponsor for their students who participated in PJAS (83.1%). Table 13 shows the frequencies and percentages from demographic questions #8, #12, and #13.

Table 13

Demographic Information Survey Questions #8, #12, and #13

Question #	Information	Survey Choices	Frequency	Percentage
8	Voluntary Sponsor	Yes	51	86.4
		No	8	13.6
		Total	59	100.0
		Missing	1	
		Total	60	
12	Required by School District to Participate	Yes	13	21.7
		No	47	78.3
		Total	60	100.0
13	Want to be Sponsor for PJAS	Yes	49	83.1
		Yes & No	2	3.4
		No	8	13.6
		Total	59	100.0
		Missing	1	
		Total	60	

Answers to questions #8, #12, and #13 on the demographic information survey were coded (1 point for a “no” answer and 2 points for a “yes” answer) in order to determine the amount of self-control middle school science teachers maintained in sponsoring students in PJAS science fair competitions. The Teacher-Self Control total score was calculated and total scores were ranked. The frequency and percentage for the *Teacher-Self Control* total scores are listed in Table 14.

Table 14

Teacher-Self Control Total Scores

Total Score	Frequency	Percentage
1	0	0.0
2	2	3.3
3	38	63.3
4	13	21.7
5	3	5.0
5.5	2	3.3
6	2	3.3
Total	60	100.0

A total score of 3 points from the scored responses represented teachers who possessed total control over their ability to sponsor students in PJAS competitions. In this study, 63.3% of the teachers felt they had total control over their participation in PJAS competitions. A total score between 4 points to 5.5 points represented teachers who had some control over their participation as a PJAS sponsor. In this study, 29.0% of the teachers felt they had some control over their participation in PJAS competitions. A total score of 6 points represented teachers who had no control over being a PJAS sponsor. Only 3.3% of the teachers in this sample reported no control. A total score of 1 or 2 represented teachers who did not answer all three demographic questions.

Demographic information question #9 required teachers to report the average number of their students who received a first place award in a PJAS science fair competition. This question on the demographic information survey was included to help determine the competitive nature of the teachers. If several of their students achieve first place awards, then this may suggest a competitive nature in the teachers. Table 15 shows the distribution of question #9 from the demographic information survey.

Table 15

Demographic Information Survey Question #9

Question #	Information	Survey Choices	Frequency	Percentage
9	Number of Students Receiving First Place Award in PJAS Competition	1	1	1.7
		2	7	12.1
		3	12	20.7
		4	14	24.1
		5 or more	24	41.4
		Total	58	100.0
		Missing	2	
		Total	60	

In this study, 41.4% of the teachers had an average of five or more students who received first place awards in PJAS science fair competitions. All students who meet the approved criteria receive a first place award; therefore, teachers may have more than one student who receives a first place award in a PJAS competition. The percentage of teachers who had at least three first place award winners at a PJAS competition was 86.2%. Two teachers in the sample did not respond to this question.

Questions #10 and #11 on the demographic information survey identified the teachers who required student participation in science fair competitions. Table 16 lists the distribution for question #10 and question #11 on the demographic information survey.

Table 16

Demographic Information Questions #10 and #11

Question #	Information	Survey Choices	Frequency	Percentage
10	Require students to conduct science fair projects	Yes - all students	33	55.0
		Yes- students who chose to participate	12	20.0
		No	13	21.7
		Other	2	3.3
		Total	60	100.0
11	Require students to compete in science fair competitions	Yes - all students	4	6.7
		Yes- students who chose to participate	19	31.7
		No	36	60.0
		Other	1	1.7
		Total	60	100.0

Of the teachers surveyed, 55.0% of the sample required students to conduct a science fair project. Another 20.0% of the teachers allowed their students to choose whether or not the student wanted to conduct a science fair project. Only 21.7% of the teachers surveyed did not require students to complete a science fair project. The other 3.3% of the teachers required students to conduct a science fair project once every five years or required only certain grade levels of students such as sixth grade and eighth grade to conduct science fair projects. Question #11 on the demographic information survey showed that 60.0% of the teachers in this sample do not require their students to participate in science fair competitions. Only 6.7% of the teachers in this study required students to participate in science fair competitions.

Demographic information questions #14 and #15 identified the amount of monetary compensation received by teachers who have students participate in PJAS science fair competitions. Table 17 lists the distribution of demographic questions #14 and #15 about monetary compensation for PJAS teacher sponsors.

Table 17

Demographic Information Survey Questions #14 and #15

Question #	Information	Choices	Frequency	Percentage
14	Monetary Compensation Provided	Yes	19	31.7
		No	41	68.3
		Total	60	100.0
15	How Much?	0	40	74.1
		$10.00 per student	1	1.9
		$50.00 for supplies	1	1.9
		$200.00	1	1.9
		$250.00	1	1.9
		$300.00	1	1.9
		$400.00	2	3.7
		$420.00	1	1.9
		$450.00	1	1.9
		$500.00	1	1.9
		$580.00	1	1.9
		$800.00	1	1.9
		$980.00	1	1.9
		$3000.00	1	1.9
		Total	54	100.0
		Missing	6	
		Total	60	

Of all of the teachers surveyed in this sample, 68.3% did not receive any monetary compensation for their time spent preparing students for PJAS science fair competitions. Of the 31.7% of the teachers who were compensated with money, the amount of compensation ranged from $10 per student to $3,000 per year. Other teacher responses to question #15 that were not a specific monetary amount included: hourly rate, money amount varies from year to year, one day flex time, and total costs are covered. Overall, most middle school science teachers *did not* receive any monetary compensation for their time preparing students for PJAS science fair competitions. Question #15 on the demographic information survey was not answered by six of the participants in this study.

Question #16 on the demographic information survey identified the amount of time teachers spent preparing students for science fair competitions. Forty-five percent of the middle school science teachers in this sample spend 50 to 150 hours preparing students for competitions and 38.3% spend less than 50 hours preparing students. Table 18 lists the results of question #16 from the demographic information survey.

Table 18

Demographic Information Survey Question #16

Question #	Information	Survey Choices	Frequency	Percentage
16	Teacher Hours	0 hours	1	1.7
		Less than 50 hours	23	38.3
		50-150 hours	27	45.0
		More than 150 hours	9	15.0
		Total	60	100.0

Science Fair Survey Data

The Science Fair survey from the questionnaire utilized in this study quantified teacher attitudes towards science fair competitions. The survey contained 13 statements about science fair competitions and required teachers to rate their attitudes towards each statement as "strongly agree", "moderately agree", "moderately disagree", or "strongly disagree". Table 19 lists the item analysis for each response to every statement on the Science Fair survey. Statements #6, #8, and #9 each had one missing response.

Table 19

Science Fair Survey Item Analysis – Percentages

Question #	Statement	Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1	Science fairs are an outdated idea and have no value in the science programs of modern schools.	3.3	11.7	11.7	73.3
2	Large cash and scholarship awards detract from the real purposes of science fairs.	0.0	18.3	31.7	50.0
3	Science fairs promote interest and enthusiasm about science.	61.7	30.0	8.3	0.0
4	Science fairs provide an opportunity for students to learn about the research of their fellow students.	68.3	30.0	0.0	1.7
5	Independent science research projects are valuable, but judging them in a science fair setting is counterproductive.	5.0	21.7	48.3	25.0
6	The opportunity to explain one's research to an outside observer (judge) enhances a student's interest in the research he/she has done.	54.2	39.0	6.8	0.0
7	Science fairs give students valuable experience in communication skills.	88.3	10.0	1.7	0.0
8	Science fairs put too much pressure on students.	3.4	16.9	44.1	35.6
9	The quality of judging at science fairs is generally good.	10.2	76.3	10.2	3.4
10	Science fairs are a logical evaluation tool for *standards*-based education.	23.3	51.7	15.0	10.0
11	Science fairs give interested students an opportunity to interact with other students who are interested in science.	63.3	33.3	1.7	1.7
12	Science fair judges should be trained or certified.	23.3	46.7	26.7	3.3
13	If my district did not require participation, I would not involve my students in science fair competitions.	8.3	13.3	20.0	58.3

The highest percentages of middle school science teachers from the sample in this study strongly agreed with statements #3, #4, #6, #7, and #11. The science teachers in this study strongly agreed that science fair competitions promote student interest in science and provide opportunities for students such as learning about research, communication skills, and the opportunity to interact with other student scientists. The teachers surveyed moderately agreed with statements #9, #10, and #12 that addressed conditions of the science fair competition such as the need to improve the quality of judging, using science fairs as an evaluation tool, and providing training for science fair judges.

The majority of middle school science teachers in the sample strongly disagreed with statements #1, #2, and #13. Teachers surveyed in this study do not feel that science fair competitions are outdated, that scholarships detract from the purpose of the competitions, or that they would not involve their students in science fair competitions if not required to do so. Many of the teachers in the sample moderately disagreed with statements #5 and #8. Teachers moderately disagreed that judging at a science fair competition is counterproductive or that science fair competitions place too much pressure on students.

The researcher calculated a Teacher Attitude total score for each teacher by scoring responses to every statement on the Science Fair survey and then tallying those scores. Responses to statements #1, #2, #5, #8, #12, and #13 on the survey received a score of one point for the response strongly agree, two points for the response moderately agree, three points for the response moderately disagree, and a score of four points for the response strongly disagree. Responses to statements #3, #4, #6, #7, #9, #10, and #11 on the survey received the reverse scoring. Statements #2 and #12 were eliminated from the Teacher Attitude total score because the answers to these statements were determined by the researcher to be indirect measurements of attitudes towards science fair competitions.

Teacher Attitude total scores were ranked from highest to lowest and then grouped according to ranges determine by the SPSS program. The majority of this sample (88.4%), represented by groups 1 and 2, held positive attitudes towards science fair competitions. No teacher in the sample for this study held a completely negative attitude towards science fair competitions. Table 20 lists the distribution for each teacher attitude.

Table 20

Science Fair Survey Total Scores

Teacher *Attitude Gradient*	Group	Total Score Range	Frequency	Percentage
Strongest Positive Attitude	1	39-44	25	41.7
	2	31-38	28	46.7
Neutral Attitude	3	25-30	6	10.0
	4	17-24	1	1.6
Strongest Negative Attitude	5	11-16	0	0.0
		Total	60	100.0

Additionally, the teacher responses to the statements on the Science Fair survey in this study were analyzed for range of responses to each statement, mean, and standard deviation. If a statement received a minimum and maximum score ranging from 1 to 4 points then every possible response was selected by at least one teacher in the sample. If a range of 1 to 4 points does not appear, then some of the responses for each statement were not selected by any of the teachers in the sample.

Statements #1, #3, #4, #5, #8, #9, #10, #11, and #12 all received teacher responses in all categories: strongly agree, moderately agree, moderately disagree, and strongly disagree. Statement #2, asking if "cash and scholarship awards detract from the real purposes of science fairs" did not receive any strongly agree responses from teachers. Statement #6 and statement #7 did not receive any strongly disagree responses from the teachers in the sample of this study. Statement #6 asked teachers if the opportunity to explain one's research to an outside observer (judge) enhances a student's interest in the research and statement #7 asked teachers about science fairs giving students valuable experience in communication skills. Table 21 lists the minimum and maximum values of teacher responses, the mean, and the standard deviation for every statement on the Science Fair survey.

Table 21

Science Fair Survey Descriptive Statistics

#	Statement	Minimum	Maximum	Mean	Standard Deviation
1	Science fairs are an outdated idea and have no value in the science programs of modern schools.	1	4	3.55	.832
2	Large cash and scholarship awards detract from the real purposes of science fairs.	2	4	3.32	.770
3	Science fairs promote interest and enthusiasm about science.	1	4	3.53	.650
4	Science fairs provide an opportunity for students to learn about the research of their fellow students.	1	4	3.65	.577
5	Independent science research projects are valuable, but judging them in a science fair setting is counterproductive.	1	4	2.93	.821
6	The opportunity to explain one's research to an outside observer (judge) enhances a student's interest in the research he/she has done.	2	4	3.47	.626
7	Science fairs give students valuable experience in communication skills.	2	4	3.87	.389
8	Science fairs put too much pressure on students.	1	4	3.12	.811
9	The quality of judging at science fairs is generally good.	1	4	2.93	.583
10	Science fairs are a logical evaluation tool for *standards*-based education.	1	4	2.88	.885
11	Science fairs give interested students an opportunity to interact with other students who are interested in science.	1	4	3.58	.619
12	Science fair judges should be trained or certified.	1	4	2.10	.796
13	If my district did not require participation, I would not involve my students in science fair competitions.	1	4	3.28	.993

Figure 3 also shows the mean for each statement on the Science Fair survey and the standard deviation for each statement. The figure pictorially shows the statements that received similar responses from the teachers in this study. Statement #13 received the widest range of responses from teachers. Statement #13 asked if the school district did not require participation would teachers still involve their students in science fair competitions. Statement #7 received the narrowest range of responses from teachers. Statement #7 asked teachers if science fairs provide students with valuable communication skills.

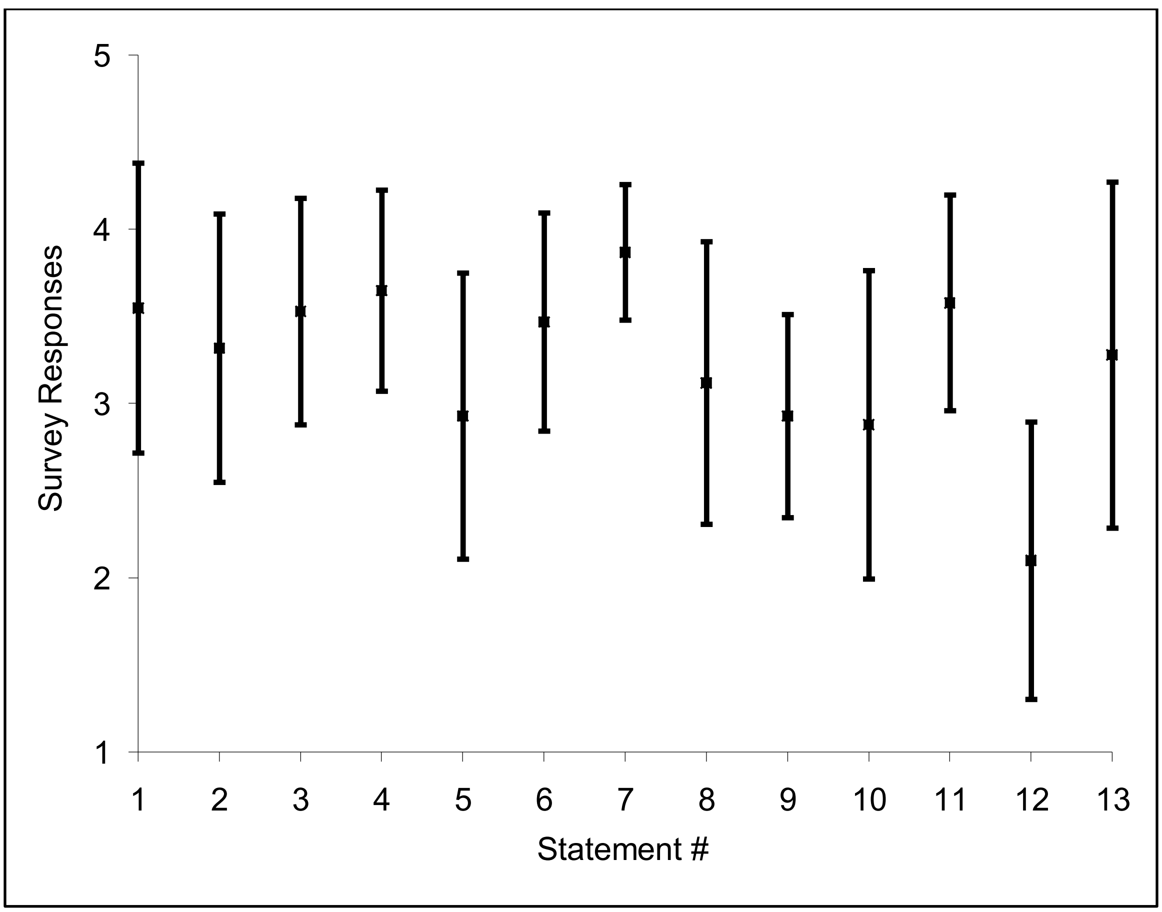


Figure 3. Mean and standard deviation of Science Fair survey responses.

Science Fair Survey and Demographic Data

Using a Pearson correlation, results from the Science Fair survey and results from the demographic survey were compared. Table 22 shows the Science Fair survey questions that produced a significant correlation with the demographic data.

Table 22

Correlation Values of Demographic Data with Science Fair Survey Responses

Science Fair Survey Questions	Demographic Questions		
	#8 voluntary sponsor	#11 require students to compete	#13 want to be a PJAS sponsor
#1 Science fairs are an outdated idea and have no value…	-.283		
#2 Large cash and scholarship awards detract…		-.264	
#3 Science fairs promote interest and enthusiasm…	.409		
#5 Independent science research projects are valuable, but judging them in a science fair setting is counterproductive.	-.269		
#7 Science fairs give students valuable experience in communication skills.	.273		
#8 Science fairs put too much pressure on students	-.383		
#10 Science fairs are a logical evaluation tool for *standards*-based education		.326	
#13 If my district did not require participation, I would not involve my students …	-.478		.480

Teachers who voluntarily sponsored students showed a significant correlation with six questions on the Science Fair survey. Teachers in this study who voluntarily sponsored student in PJAS competitions agreed that science fairs promote interest and enthusiasm in science and give students valuable experience in communication skills. These teachers also disagreed that science fairs were outdated, that judging science fair projects was counterproductive, that science fair competitions put too much pressure on students, and would involve their students even if their district did not require participation. Teachers who required students to compete in PJAS competitions agreed that science fairs were a logical tool for evaluation.

Descriptive statistics for the demographic data compared with the Science Fair survey groupings for a neutral or negative teacher attitudes towards science fairs (11.6% of the sample) and positive teacher attitudes towards science fairs (88.4% of the sample) are shown in Table 23.

Table 23

Science Fair Survey Categories and Demographic Data Percentages

#			positive attitude score percentages	neutral or negative attitude score percentages	Total percentages
1	School Type	private	85.3	14.7	100.0
		public	92.3	7.7	100.0
2	Gender	male	78.6	21.4	100.0
		female	91.3	8.7	100.0
8	Voluntary Teacher Participation in PJAS	yes	94.2	5.8	100.0
		no	62.5	37.5	100.0
10	Teacher Requires Students to Conduct Science Fair Project	yes	100.0	0.0	100.0
		student choice	83.3	16.7	100.0
		no	66.6	33.3	100.0
		other	97.0	3.0	100.0
11	Teacher Requires Students to Compete in Science Fair Competitions	yes	100.0	0.0	100.0
		student choice	86.1	13.9	100.0
		no	89.5	10.5	100.0
		other	100.0	0.0	100.0
12	Required by District to Participate	yes	76.9	23.1	100.0
		no	91.5	8.5	100.0
13	Want to be PJAS Sponsor	yes	92.2	7.8	100.0
		no	62.5	37.5	100.0
14	Monetary Compensation	yes	94.7	5.3	100.0
		no	85.4	14.6	100.0

Table 23 compares the two categories of teachers in this study based on the results of the Science Fair survey total score. Teachers were grouped into two categories: those with positive attitudes towards science fairs (88.4% of the total sample) and those with neutral or negative attitudes towards science fairs (11.6% of the total sample). For each response to several demographic questions, the percentages of teachers from each category (positive or neutral/negative) who chose each response were calculated. Demographic questions not included in Table 23 showed no significant difference in percentages between groups.

A higher percentage of teachers with neutral/negative attitudes towards science fairs were employed by private schools, were male, and *did not* voluntarily sponsor students in PJAS competitions. Additionally, these teachers did not require their students to conduct science fair projects or to compete in science fair competitions. A higher percentage (23.1%) of the teachers in this study with neutral/negative attitudes towards science fair projects was required to participate in PJAS by their school district than not (8.5%). This pattern was the opposite for the teachers who held positive attitudes towards science fairs. Teachers with neutral/negative attitudes towards science fair did not want to be PJAS sponsors (37.5%) and received no monetary compensation. Again, this was not true for teachers with positive attitudes towards science fairs.

Learning Preference Scale – Teachers Survey Data

Data from the LPST survey started as a raw total score that was converted into a percentile ranking using the Reference Group Data from United States teachers (Appendix K). Percentile ranks represented the strength of the teacher preferences for individualistic, cooperative, or competitive student-learning modes in the classroom. Percentile ranks were grouped and the frequency and percentage for each group were calculated as shown in Table 24.

Table 24

LPST Survey Grouping Results

Groups	Frequency	Percentage
Individualistic	22	36.7
Cooperative	23	38.3
Competitive	15	25.0
Total	60	100.0

The individualistic and cooperative student-learning modes comprised the highest percentage of teacher choices from the sample in this study. The middle school science teachers in this study least preferred the competitive student-learning mode. Once teachers were categorized into one of the three different student-learning modes, this researcher conducted further data analyses with demographic data, Pearson correlations, and two different binary logistic regressions of the data variables.

Learning Preference Scale –Teachers Survey Data and Demographic Data

Using a Pearson correlation, results from the LPST survey and results from the demographic survey were compared. No survey groups (cooperative, competitive, individualistic) showed a significant correlation with any of the demographic data but when raw scores for the survey were analyzed, a few significant correlations were identified for teachers who preferred the individualistic student-learning style. Table 25 shows these results.

Table 25

Significant Correlation Values Between Teacher Preference and Demographic Data

LPST Raw Score Groups	Demographic Questions #9 number of students receiving first place awards	#16 number of hours spent preparing students
Individualistic Raw score	.269	.297

Teachers with the highest raw score on the LPST survey for the individualistic student learning mode in the classroom showed a positive significant correlation with number of students who received a first place award and the number of hours spent preparing students for PJAS competitions. These teachers had more than five students receiving a first place award at PJAS competitions, and these teachers spent 50-150 hours preparing students for competitions.

Descriptive statistics of the LPST groups (individualistic, cooperative, and competitive) and several questions from the demographic data are shown in Table 26. Demographic questions not included in Table 26 showed no significant differences in percentages between LPST groups.

Table 26

LPST Survey Categories and Demographic Data Percentages

Question #			Competitive	Cooperative	Individualistic	Total Percentage
1	School Type	private	8.3	18.3	16.7	100.0
		public	16.7	20.0	20.0	
2	Gender	male	3.3	13.3	6.7	100.0
		female	21.7	25.0	30.0	
6	Grade Level Taught	Middle School	23.3	33.3	35.0	100.0
		other	1.7	5.0	1.7	
8	Voluntary Teacher Participation in PJAS	yes	18.6	35.6	32.2	100.0
		no	5.1	3.4	5.1	
10	Teacher Requires Students to Conduct Science Fair Project	yes	30.3	30.3	39.4	100.0
		student choice	25.0	41.7	33.3	
		no	15.4	53.8	30.8	
		other	0.0	50.0	50.0	
11	Teacher Requires Students to Compete in Science Fair Competitions	yes	0.0	3.3	3.3	100.0
		student choice	8.3	10.0	13.3	
		no	16.7	23.3	20.0	
		other	0.0	1.7	0.0	
12	Required by District to Participate	yes	10.0	5.0	6.7	100.0
		no	15.0	33.3	30.0	
13	Want to be PJAS Sponsor	yes	21.7	33.3	26.7	100.0
		no	1.7	3.3	8.3	

Overall, male teachers in the sample preferred the cooperative student-learning mode while female teachers in the sample showed no significant difference among the three different student-learning modes. The majority of teachers in all preference groups taught middle level grades, volunteered to participate as sponsors for PJAS, and was not required by their school district to participate in PJAS.

The highest percentage of teachers in the study who preferred the competitive student-learning mode required students to conduct science fair project but *did not require* students to compete in science fair competitions. The teachers who preferred the cooperative and individualistic student-learning modes did not require their students to conduct science fair projects or participate in science fair competitions.

Further Data Analysis

A Pearson correlation was calculated to determine any relationships between middle school science teachers' attitudes towards science fair competitions and their preferences for a particular student-learning mode. Data from the groupings of Teacher Total Attitude score from the Science Fair survey and the Teacher Preference Category groups from the LPST survey were analyzed for correlations. The results are shown in Table 27.

Table 27

Pearson Correlation Results

		Attitude Science Fair survey	Cooperative Student-Learning Mode	Competitive Student-Learning Mode	Individualistic Student-Learning Mode
Science Fair Survey	Pearson Correlation	1	.076	-.002	.010
	Significance (2-tailed)		.576	.988	.940
	N	57	57	56	55

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

No significant correlation was shown to exist between middle school science teachers' positive attitudes towards a science fair competition and teachers' preferences for a competitive, cooperative, or individualistic student-learning mode.

A binary logistic regression was performed to determine if certain variables from this study were significant predictors of the teachers' answers to demographic question #11 which identified if middle school science teachers required their students to compete in science fair competitions. The variables used in the regression included demographic questions #8, #12, #13, the Teacher Total Attitude scores, and the raw scores for teacher preferences for every student-learning mode.

Demographic question #11 was re-coded for the regression to a strictly "Yes/No" response instead of the original four options available. The answer

“Yes (all students)” was coded as a value of 1. “Yes (only students who choose to participate)” and “No” responses were coded together as the same value of 2. Data from teachers who responded “Other” to demographic question #11 were not included in the regression. Table 28 lists the data cases included in the regression.

Table 28

Case Processing Summary - First Binary Logistic Regression

Unweighted Cases		N	Percent
Selected Cases	Included in Analysis	57	95.0
	Missing Cases	3	5.0
	Total	60	100.0
Unselected Cases		0	.0
Total		60	100.0

Table 29 shows the results of the logistic regression

Table 29

First Binary Logistic Regression of Variables

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	Demo8(1)	-1.555	1.245	1.562	1	.211	.211
	Demo12(1)	-2.184	.977	4.998	1	.025	.113
	Demo13(1)	.535	1.013	.279	1	.597	1.707
	SFS	-.040	.074	.301	1	.583	.960
	Coop_raw_score	-.090	.082	1.214	1	.271	.914
	Comp_Raw_score	.007	.071	.010	1	.922	1.007
	Ind_raw_score	-.130	.086	2.287	1	.130	.878
	Constant	9.862	4.919	4.019	1	.045	19196.370
Step 2(a)	Demo8(1)	-1.548	1.242	1.555	1	.212	.213
	Demo12(1)	-2.157	.938	5.285	1	.022	.116
	Demo13(1)	.537	1.012	.282	1	.596	1.711
	SFS	-.040	.073	.292	1	.589	.961
	Coop_raw_score	-.089	.081	1.203	1	.273	.915
	Ind_raw_score	-.126	.079	2.573	1	.109	.881
	Constant	9.898	4.903	4.076	1	.044	19886.993
Step 3(a)	Demo8(1)	-1.280	1.124	1.297	1	.255	.278
	Demo12(1)	-2.064	.914	5.105	1	.024	.127
	SFS	-.023	.066	.122	1	.727	.977
	Coop_raw_score	-.076	.076	.997	1	.318	.927
	Ind_raw_score	-.130	.078	2.767	1	.096	.878
	Constant	9.109	4.568	3.975	1	.046	9031.965
Step 4(a)	Demo8(1)	-1.416	1.064	1.770	1	.183	.243
	Demo12(1)	-2.052	.919	4.985	1	.026	.129
	Coop_raw_score	-.076	.076	1.021	1	.312	.926
	Ind_raw_score	-.133	.078	2.884	1	.089	.875
	Constant	8.455	4.150	4.150	1	.042	4697.962
Step 5(a)	Demo8(1)	-1.327	1.052	1.591	1	.207	.265
	Demo12(1)	-1.891	.889	4.522	1	.033	.151
	Ind_raw_score	-.115	.075	2.385	1	.123	.891
	Constant	5.144	2.405	4.573	1	.032	171.420
Step 6(a)	Demo12(1)	-1.268	.677	3.512	1	.061	.281
	Ind_raw_score	-.111	.073	2.326	1	.127	.895
	Constant	3.750	2.070	3.283	1	.070	42.523
Step 7(a)	Demo12(1)	-1.129	.653	2.992	1	.084	.323
	Constant	.659	.318	4.297	1	.038	1.933
Step 8(a)	Constant	.391	.270	2.096	1	.148	1.478

a Variable(s) entered on step 1: Demo8, Demo12, Demo13, SFS, Coop_raw_score, Comp_Raw_score, Ind_raw_score.

According to the regression, no variables were statistically significant predictors of the demographic question #11. Table 26 shows the insignificant variables in the regression removed one at a time by the SPSS program until only significant variables remained. All variables were removed from the regression.

Another binary logistic regression was performed to determine if other variables in this study were significant predictors for the answer to demographic question #11. The variables included in the second binary logistic regression included demographic question #10, Science Fair survey Teacher Attitude total scores, and the raw scores for teacher preferences for every student-learning mode. Demographic question #10 was also recoded for the regression in the same manner as demographic question #11 and labeled as demographic question "10r".

Table 30 lists the data cases included in the second regression.

Table 30

Case Processing Summary – Second Binary Logistic Regression

Unweighted Cases		N	Percent
Selected Cases	Included in Analysis	57	95.0
	Missing Cases	3	5.0
	Total	60	100.0
Unselected Cases		0	0
Total		60	60

These variables were chosen because they represented the components for the theoretical framework of this study; the theory of planned behavior. If middle school science teachers possess positive attitudes towards science fair competitions (behavioral belief), prefer a competitive student-learning mode (normative belief) in their classrooms, and control their own and their students' participation in science fair competitions (control belief and actual behavioral control), then the predicted behavioral intention and resulting behavior of these teachers would be the requirement of student participation in science fair competitions. Table 31 shows the results of the second logistic regression.

Table 31

Second Logistic Regression of Variables

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1(a)	Demo10r(1)	-2.557	1.119	5.226	1	.022	.078
	SFS	-.025	.060	.178	1	.674	.975
	Coop_raw_score	-.088	.077	1.320	1	.251	.915
	Comp_Raw_score	-.059	.069	.726	1	.394	.943
	Ind_raw_score	-.072	.083	.760	1	.383	.930
	Constant	10.271	4.680	4.817	1	.028	28881.921
Step 2(a)	Demo10r(1)	-2.552	1.116	5.234	1	.022	.078
	Coop_raw_score	-.090	.077	1.361	1	.243	.914
	Comp_Raw_score	-.060	.069	.762	1	.383	.942
	Ind_raw_score	-.073	.083	.789	1	.374	.929
	Constant	9.425	4.186	5.070	1	.024	12391.687
Step 3(a)	Demo10r(1)	-2.449	1.105	4.912	1	.027	.086
	Coop_raw_score	-.090	.076	1.395	1	.238	.914
	Ind_raw_score	-.103	.076	1.840	1	.175	.902
	Constant	8.543	4.048	4.455	1	.035	5132.736
Step 4(a)	Demo10r(1)	-2.276	1.091	4.351	1	.037	.103
	Ind_raw_score	-.084	.072	1.349	1	.245	.920
	Constant	4.696	2.264	4.303	1	.038	109.527
Step 5(a)	**Demo10r(1)**	-2.264	1.086	4.344	1	**.037**	.104
	Constant	2.398	1.044	5.271	1	**.022**	11.000

a Variable(s) entered on step 1: Demo10r, SFS, Coop_raw_score, Comp_Raw_score, Ind_raw_score.

Variables that were not significant predictors for the answer to demographic question #11 were removed one at a time until only significant variables remained. According to the regression, demographic question #10 is statistically significant for predicting whether or not middle school teachers require students to participate in science fair competitions. Demographic question #10 asked teachers whether or not they required students to conduct science fair projects.

Proper interpretation of the results of the second binary logistic regression required the use of the following equation:

$$\text{Log } (n/1- n) = \beta_0 + \beta_1 * x$$

Or

$$\pi = e^{\beta 0 + \beta 1 * x} / (1 + e^{\beta 0 + \beta 1 * x})$$

= probability of responding “no” to demographic question #11

The use of this equation allowed for the following conclusions: (a) teachers who respond “no” to demographic question #10 are predicted to respond “no” to demographic question #11, 91.6% of the time, (b) teachers who respond “yes” to demographic question #10 are predicted to respond “yes” to demographic question #11, 53.3% of the time. Demographic question #10 confirmed that teachers required students to conduct science fair projects, and demographic questions #11 confirmed that teachers required students to compete in science fair competitions.

Summary

The questionnaire for this study included a demographic survey, a Science Fair survey, and a LPST survey. Data from each of the surveys were analyzed separately, several sets of data were correlated, and several data variables were placed into two different binary logistic regressions. Data analyses for this study began with descriptive statistics for the demographic information survey, the Science Fair survey, and the LPST survey. Further analysis included total scores representing teacher control, teacher attitude, and teacher preferences for a student-learning mode. A Pearson correlation measured the degree of relationships between teacher attitudes and teacher preferences for a particular student-learning mode and the demographic data. Finally, binary logistic regressions were used to identify any significant variables in this study that would predict the middle school science teacher behavior of requiring middle school students to participate in science fair competitions.

The analysis of all of the demographic data showed that the majority of middle school science teachers from the sample in this study were female, white, employed by a private school, had 10 to 20 years teaching experience in middle school science, had 1 to 10 years of experience sponsoring students in PJAS science fair competitions, were voluntary sponsors, were not required by their school district to sponsor students, showed success at PJAS with 5 or more of their students receiving a first place award, and received no monetary compensation for their efforts. The majority of the teachers in the sample required their students to conduct science fair projects but *did not require* their students to participate in science fair competitions.

Analysis of the Science Fair survey data showed that the majority of teachers who sponsored students in the PJAS science fair competitions held positive attitudes towards science fair competitions. The middle school science teachers from this study held strong attitudes in support of the benefits that students can gain from participation in science fair competitions such as communication skills, interest in research, and networking with other student scientists. Analysis of select data variables with binary logistic regressions suggested that middle school teachers who required their students to participate in science fair competitions also required their students to conduct science fair projects.

The next chapter summarizes the data from this study and outlines implications and further research suggested by the results of this study.

CHAPTER 5

SUMMARY AND DISCUSSIONS

Introduction

This chapter summarizes the results from this descriptive study exploring the teacher behavior related to required student participation in science fair competitions. The researcher surveyed middle school science teachers (N= 60) who sponsored students in PJAS science fair competitions to quantify their attitudes towards science fair competitions, identify their preferences for different student-learning modes, and explore their motives for required student participation in science fair competitions. Data collected were analyzed using descriptive statistics, Pearson correlations, and binary logistic regressions.

The researcher acknowledged five teacher motives: (1) the inclusion of student-conducted experimental science fair projects in the science curriculum, (2) the expectations of school administrators for teachers and students to participate in science fair competitions, (3) the competitive nature of the teacher, (4) the skills practiced and knowledge gained by students who participate in science fair competitions, and (5) the preparation of students for standardized science assessments. The theory of planned behavior was utilized for predicting teacher behavior based on teacher attitudes, teacher preferences for student learning, and the amount of teacher control over participation in science fair competitions. The data answered the following research questions:

1. What is the relationship between middle school science teacher attitudes and student participation in science fair competitions?
2. What is the relationship between middle school science teacher preferences for a particular student-learning mode and student participation in science fair competitions?
3. What is the relationship between middle school science teacher motives and student participation in science fair competitions?

Recommendations for further research on this topic and specific recommendations for middle school science teachers about science fair projects and science fair competitions conclude this chapter.

Summary of the Findings

The questionnaire in this study included three surveys. Data analyses for this study initiated with descriptive statistics of the demographic information survey responses and the Science Fair survey responses. Further analyses calculated total scores representing teacher control over completion of student science fair projects and participation in science fair competitions, teacher attitudes towards science fair competitions, and teacher preferences for a particular student-learning mode. Additional descriptive statistics compared the responses from the demographic data with the Science Fair survey responses and with the LPST survey responses. Pearson correlations were calculated between (1) the Science Fair survey responses and the demographic data, (2) the LPST survey responses and the demographic data, and (3) the Teacher

Attitude scores and teacher preference scores for a particular student-learning mode. Additionally, binary logistic regressions were used to identify any significant variables in this study that would predict the middle school science teacher behavior of requiring middle school students to participate in science fair competitions.

The demographic data revealed that the sample in this study consisted mostly of middle school science teachers who were female, white, employed by a private school, had 10 to 20 years of teaching experience in middle school science, voluntarily sponsored students in PJAS competitions for 1 to 10 years, were not required by their school district to sponsor students, showed success at PJAS competitions with 5 or more of their students receiving a first place award, and received no monetary compensation for their efforts. Also, the majority of the teachers in the study sample required their students to conduct science fair projects but did not require their students to participate in science fair competitions.

The Science Fair survey data showed that the majority of teachers who sponsored students in PJAS science fair competitions held positive attitudes towards science fair competitions. The middle school science teachers in the sample from this study held strong attitudes supporting the benefits that students gain from participation in science fair competitions including: communication skills, interest in research, and networking with other student scientists. Correlations identified between the Science Fair survey results and the demographic data showed teachers who voluntarily sponsored students in PJAS competitions expressed that science fairs were not outdated, nor was judging of science fair competitions counterproductive. These teachers further expressed that they would involve their students in PJAS competitions even if their district did not require student participation in the competitions.

Teachers who voluntarily sponsored students in PJAS competitions also believed science fairs promoted interest and enthusiasm in science for students and allowed students to practice valuable communications skills. Teachers who required their students to compete in PJAS competitions felt that science fair competitions were a logical evaluation tool for standards-based education. Of the teachers expressing positive attitudes towards science fair competitions, less than 20.0% required students to complete science fair projects and an even smaller percentage of those teachers even required students to participate in science fair competitions. Teachers who held neutral or negative attitudes towards science fair competitions did not require students to conduct science fair projects, and not one of those teachers required students to compete in science fair competitions.

Analysis of the LPST survey data showed teacher preferences for the cooperative student-learning mode, and the individualistic student-learning mode outnumbered teacher preferences for a competitive student-learning mode in the sample from this study. Correlations identified between the LPST survey results and the demographic data showed only one of the student-learning modes correlated with two of the demographic questions. The Pearson correlation calculation showed a significant correlation for teachers who prefer the individualistic student-learning mode, who have more than five students receiving a first place award at PJAS competitions, and who spend 50-150 hours preparing students for competitions. Male teachers in this study preferred the cooperative student-learning mode, while the female teachers in this study showed no significant preference for any of the three student-learning modes. Teachers who preferred the competitive student-learning mode required students to conduct science fair projects but *did not require* students to compete in science fair competitions. The teachers who preferred the cooperative and individualistic student-learning modes did not require their students to conduct science fair projects or to participate in science fair competitions.

Using the theoretical framework from this study, an analysis of select data variables representing normative beliefs, behavioral beliefs, and control beliefs were compared using two different binary logistic regressions. These data variables were analyzed to determine if any of the variables would be significant predictors for the teacher behavior of requiring student participation in science fair competitions. Results from the binary logistic regressions suggested that middle school teachers who required their students to participate in science fair competitions also required their students to conduct science fair projects.

Discussions

The interpretations of the findings for this study are limited to the demographic makeup of the sample in this study. The middle school science teacher sample in this study was comprised of females of white ethnicity, who had control over their own and their students' participation in PJAS science fair competitions, who held positive attitudes towards science fairs (88.4%), and who had no particular preference for a particular student-learning mode.

The theoretical framework utilized in this study was the theory of planned behavior. According to the theory of planned behavior, three types of beliefs affect human behavior: behavioral beliefs, normative beliefs, and control beliefs (Ajzen, 1991). The middle school science teacher behavior of requiring student participation in science fair competitions can be explained if middle school science teachers possess positive attitudes towards science fair competitions (behavioral belief), prefer a competitive student-learning mode (normative belief) in their classrooms, and control their own and their students' participation in science fair competitions (control belief and actual behavioral control). According to the data collected from the sample in this study, limited ability for predicting teacher behavior was concluded.

Logistic binary regressions were conducted to determine if normative beliefs (attitudes), behavioral beliefs (student-learning mode preference), and control beliefs affected the teacher behavior of requiring students to participate in science fair competitions. According to the analyses, no variables in this study were significant predictors for the teacher behavior of requiring student participation in science fair competitions. Further analysis of the regression data from this study did show that teachers who required students to conduct science fair projects required students to participate in science fair competitions 53.3% of the time. Therefore, the teacher requirement for students to conduct science fair projects best predicted the teacher behavior of required student participation in science fair competitions for the middle school teachers in this study.

Research Question #1: Teacher Attitudes and Student Participation

Positive teacher attitudes towards science fairs equates to student participation in science fair competitions. The majority of the teachers in this sample (88.4%) held positive attitudes towards science fair projects and competitions as shown by the results of the Teacher Attitude total scores. Attitudes, according to the theory of planned behavior, influence behaviors (Ajzen, 1991). A positive attitude held by a teacher would logically influence a teacher's behavior of requiring students to conduct experimental science fair projects and to participate in science fair competitions. To answer the first research question, data from subjects in the study who held neutral or negative attitudes (11.6%) towards science fair projects and competitions were analyzed as well as teachers who held positive attitudes (88.4%).

Positive attitudes towards science fair projects and competitions can be a motive for the teacher behavior of requiring student participation in science fair competitions because of those teachers in this study with a neutral or negative attitude, only 14.0% required their students to conduct a science fair project and 0.0% required students to compete in science fair competitions. Whereas, of the teachers in this study who held positive attitudes towards science fair projects and competitions, 60.4% of them required students to conduct science fair projects and 7.5% of those teachers required their students to participate in science fair competitions.

Positive teacher attitudes towards science fair projects and competitions appears to influence the behavior of the teachers in this study suggested by the percentages of teachers who required students to conduct science fair projects and compete in science fair competitions. Additional support is shown in the correlations between the Science Fair survey statements and some of the demographic questions. Teachers in this study who voluntarily sponsored students in PJAS science fair competitions believed science fair projects and competitions were valuable to student science education and promoted interest and enthusiasm about science, as well as provided students with valuable experiences in communication skills. These data support the findings from studies conducted by Grote (1995b) and Schneider and Lumpe (1996) in which the majority of teachers held positive attitudes towards science fair competitions.

Teachers who required their students to compete in PJAS competitions felt that science fair competitions were a logical evaluation tool for standards-based education. The importance of student participation in science fair competitions is supported with the data from this study showing that over half of the teachers who required students to conduct a science fair project also required students to compete in science fair competitions. As Wilson, Cordry, and Uline (2004) pointed out, "Science fair participation stimulates deeper interest in the proposed problem for experimentation".

Research Questions #2: Teacher Preference for Student-Leaning Mode and Student Participation

No correlations existed between the Teacher Attitude score and teacher preferences for a particular student-learning mode. According to the results from this study, preference for a particular student-learning mode does not impact teacher attitudes towards science fair projects and competitions. According to the demographic data, more than half of the teachers in this study (55.0%) required their students to participate in the PJAS science fair competitions, which allowed students to experience a competitive student-learning mode, but the LPST survey results showed that most of the teachers in this study preferred the cooperative and individualistic student-learning modes (75.0%) over the competitive student-learning mode.

As for teacher behavior and preference for a particular student-learning mode, correlations existed between the individualistic student-learning mode and demographic questions #9 and #16. Teachers who preferred the individualistic student-learning mode reported more time spent with students preparing projects with consequently more student winners at the PJAS competitions than teachers who preferred cooperative or competitive student-learning modes. A teacher's preference for individual work may promote more time spent by teachers helping students with their science fair projects, hence providing more guidance for the students and more student awards at the competitions. The findings from this study support the findings from Abernathy and Vineyard (2001), Bellipanni (1994), Bunderson and Anderson (1996), Czerniak (1996), Jackson (1995), and Olsen (1985) that teachers must support students who conduct science fair projects in order to create greater successes for those students. Student resources in the form of support from teachers, librarians, or parents best predicted student success in science fair competitions (Abernathy & Vineyard, 2001; Bellipanni, 1994; Bunderson & Anderson, 1996; Czerniak, 1996; Jackson, 1995; Olsen, 1985).

Teacher preference for a competitive student-learning mode does not appear to be a motive for the science teacher behavior of requiring student participation in science fair competitions. The middle school science teachers in this study least preferred the competitive student-learning mode (25.0%). The cooperative student-learning mode (38.3%) and the individualistic student-learning mode (36.7%) comprised the highest percentages of teacher choices from the sample in this study. Preference by teachers in the sample for both the cooperative and individualistic student-leaning modes is not unusual. Owens and Barnes (1992) identified in their study that student-learning modes are not mutually exclusive in the classroom. The data from this study also support data collected in the Johnson (2006) study. The teachers in the Johnson (2006) study also preferred the cooperative student-learning style in their classrooms. The preference of the cooperative student-learning mode by the teachers in this study is encouraging because middle school students "prefer interaction with peers during the learning activities" (NMSA, 2003, p. 50). The cooperative student-learning mode allows students to interact with their peers.

Research Questions #3: Relationships Between Motives and Student Participation

The researcher acknowledged five teacher motives in this study: (1) inclusion of student-conducted experimental science fair projects in the science curriculum, (2) the expectations of school administrators for teachers and students to participate in science fair competitions, (3) the competitive nature of the teacher, (4) the skills practiced and knowledge gained by students who participate in science fair competitions, and (5) the preparation of students for standardized science assessments.

Inclusion of student-conducted experimental science fair projects in the science curriculum appears to be one motive for the behavior of middle school science teachers who required student participation in science fair competitions. Fifty-five percent of the middle school science teachers from the sample in this study required their students to conduct an experimental science fair project, with this same group including student-conducted experimental science fair projects in the science curriculum at their school. These results support the findings from Blenis (2000), Bunderson & Anderson (1996), Czerniak (1996), Czerniak & Lumpe (1996), Grote (1995b), and Schneider & Lumpe (1996) that teachers required students to conduct experimental science fair projects. Additionally, teachers in this study who required students to conduct science fair projects also required students to participate in science fair competitions 53.3% of the time. Therefore, inclusion of student-conducted experimental science fair projects in the science curriculum was a motive for the middle school science teacher behavior of requiring student participation in science fair competitions for the middle school teachers in this study.

The expectations from administrators for teachers to involve students in PJAS competitions was not found in this study to be a motive for the middle school science teacher behavior of requiring student participation in science fair competitions. Only 21.7% of the middle school science teachers in the sample for this study were required to sponsor students in PJAS competitions. More support for the conclusion that administrators did not expect PJAS participation came from analysis of the Teacher Self-Control score. Middle school science teachers in this study reported control over their decision to sponsor students in the PJAS competitions. Many of the middle school teachers in this study chose to sponsor students in PJAS competitions without monetary compensation (68.3%) and worked with students for 50 to 150 hours (45.0%) preparing the students for the PJAS science fair competitions.

The competitive nature of the science teacher was not shown to produce the science teacher behavior of required student participation in science fair competitions. As this study showed, no one specific student-learning mode correlated to the teacher behavior of requiring students to complete science fair projects or attending science fair competitions. A teacher who prefers a competitive student-learning mode is not a requirement for teachers who sponsor students in science fair competitions. Additionally, teacher gender did not show a difference in preference for a particular student-learning mode in this study. The female teachers preferred the cooperative student-learning mode (39.1%) and the Individualistic student-learning mode (37.0%) to the competitive student-learning mode (23.9%). Likewise, the male teachers in this study equally preferred the cooperative and individualistic student–learning modes (35.7%) to the competitive student-learning mode (28.6%).

No male teachers (n= 14) in this study required their students to participate in science fair competitions. Only 16.6% of the female teachers (n= 46) in this study required their students to participate in science fair competitions. These findings did not support the findings from a study by Owens (1985) showing male science teachers preferred the competitive student-learning mode. The shift in preference by teachers from a competitive student-learning mode to a cooperative-student learning mode may be due to changes in pre-service training of science teachers since the 1980's when the Owen's study was conducted. A competitive student-learning mode does not negate the presence of other student-learning modes (cooperative and individualistic) in a teacher's classroom and can exist in conjunction with the other student-learning modes (Owens & Barnes, 1992). Furthermore, a conglomerate of the different student-learning modes as part of a teacher's pedagogy would benefit all student groups in the science classroom.

Acknowledgement of skills gained by students through student-conducted science fair projects and science fair competitions such as preparation for standardized science assessment were shown by this study to lead to the teacher behavior of required student participation in science fair competitions. This motive links with positive teacher attitudes towards science fair competitions. A curriculum that includes student-conducted experimental science fair projects can allow students to experience a science curriculum that is "challenging, integrative and exploratory" (NMSA, 2003, p.11). The science fair process can provide students with academic rigor, model workplace skills, help provide equity by addressing the science achievement gap, and can include practices that are developmentally appropriate for adolescents. Teachers in this study who held positive attitudes towards science fair competitions required students to complete a science fair project or to participate in science fair competitions.

Recommendations for Further Research

This study surveyed middle school teachers who sponsored students in a PJAS science fair competition. This descriptive study showed that positive teacher attitudes towards student-conducted science fair projects and student completion of science fair projects best motivated teachers to require student participation. Since attitude appears to be the strongest deciding factor for teacher behavior, further studies should focus on what experiences shape the positive attitudes of teachers who require student participation in science fair competitions. The future study should catalogue the personal experiences of those teachers to determine what experiences as a student, as a pre-service teacher, or as a teacher that developed their positive attitudes towards science fairs.

If conducted properly, experimental science fair projects and student participation in science fair competitions can be part of an exemplary middle school science curriculum. The science fair process can provide students with academic rigor, can model workplace skills and help provide equity by addressing the science achievement gap, and also can include practices that are developmentally appropriate for adolescents. Teachers should examine new or existing pedagogy in their science curricula to improve the science fair process and provide positive experiences for students. Future studies should analyze the pedagogy utilized by teachers and the curriculum experienced by students who are successful to prevent negative student and teacher attitudes towards science fair projects and competitions.

Recommendations for Middle School Science Teachers

Beyond having positive attitudes towards science fairs, another identified motive for the teacher behavior of required student participation in science fair competitions in this study was the inclusion of the science fair project in the science curriculum. Make student-conducted science fair projects an integral part of the science curriculum at the middle school level. At the high school level, provide an elective science course specifically designed for scientific research by students. By incorporating science fair projects into the science curriculum, students can schedule time into their busy daily schedules to work with the science teacher.

Teachers should

- reflect on their pedagogy for student-conducted science fair projects to determine ways to reduce failure for students and stress for both the teacher and the students.
- provide support for students in the form of resources, expertise, and guidance so that students will experience success.
- expand support systems to include expertise from other scientific professionals, other professionals, and parents and integrate the science fair project process with other subjects to expand the support system for students.
- provide for students a local science fair competition that employs an award scheme with more than one winner.

- encourage as many students as possible to experience a competitive science fair.
- require students to compete in several different science fair competitions in the same school year with the same project.

As this study shows, middle school teachers do not need to be competitive to be effective sponsors of students in science fair competitions. The researcher encourages middle school science teachers to reflect upon their own attitudes towards science fair projects and competitions. If positive or negative attitudes exist, teachers should examine why those attitudes are held to determine if those attitudes are based on educational research or a teacher's own personal experiences. If teacher attitudes are not based upon educational research, then teachers should reexamine their beliefs supporting their attitudes towards student involvement in science fair projects and competitions.

The downfall to never requiring middle school students to participate in science fair competitions was shown in a study by Blenis (2000) when only 5.0% of the students voluntarily chose to complete a science fair project. Few middle school students will experience conducting a science fair project if given the choice to *not* conduct a project. Several researchers (Blenis, 2000; Syer & Shore, 2001) recommended mandatory student participation in science fair projects and science fair competitions if students have their choice of project topic and if the teachers provided the necessary support system for students. The researcher encourages all middle school science teachers to require student-conducted science fair projects in their school's science curriculum with the appropriate pedagogy and support system that enables students to succeed.

Summary and Reflection

A significance of this study was to help science teachers who were undecided about including science fair projects and competitions in their curriculum to make an informed decision about this issue. Student participation in science fair competitions can be beneficial to middle school students if resources are provided to the student. Students require time, guidance, and materials to complete a successful science fair project. Middle school students will not voluntarily choose to conduct science fair projects; and therefore, educators must provide students with the best possible pedagogy for achieving content and skills in science by utilizing science fair projects.

In the scientific world, scientists communicate their findings from their research. No other pedagogy best duplicates how scientists work and allows students to experience the job of a scientist. Requiring middle school students to conduct a science fair project will help students gain scientific skills, content, and prepare them for standardized science tests. Encouraging students to participate in science fair competitions can also provide students with experiences and skills they may not achieve in the regular classroom. A bit of encouragement from the teacher can help students overcome anxieties about science fair projects and competitions.

Positive teacher attitudes towards science fairs drive the teacher behavior of required student participation in science fair competitions. Recommendations for teachers from this study include the following:

- incorporate student-conducted science fair projects into the middle school level science curriculum.
- provide classroom time to complete components of the science fair project (choosing topic, identifying problem, writing hypothesis, and procedure, collecting and analyzing data, drawing conclusions).
- model and practice the different components of a science fair project in the science classroom.
- integrate with other subject areas.
- provide a local school science fair with the recommended judging system where all students participate and can achieve success.
- strongly encourage students to participate in several regional and state science fair competitions.

In reflecting on this dissertation project and process, a positive teacher attitude is paramount to the success of student-conducted science fair projects. Teacher attitudes permeate the curriculum and pedagogy that middle school students experience. A better understanding of teacher attitudes and how those attitudes can be formed, changed, or influenced in regards to student-conducted science fair projects and science fair competitions is necessary. This study has also influenced the researcher by precipitating the development of a high school level research class to provide students the necessary components to be successful at science fair projects and competitions. This includes supervised time during the school day for students to complete their work and weekly support and guidance from the teacher or other scientific professionals in the achievement of their goal – the completion of a valid student-conducted research project.

REFERENCES

Abernathy, T.V., & Vineyard, R.N. (2001). Academic competitions in science. *Clearing House, 74*(5), 269-277.

Adams, S. (1967). The relationship between parental occupational class and success in science fair competition (Doctoral dissertation, Oklahoma State University, 1967). *Dissertation Abstracts International.*

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes.* Retrieved December 30, 2003, from http://www-unix.oit.umass.edu/~ aizen/publications.html

Ajzen, I. (2002). *Constructing a TpB questionnaire: Conceptual and methodological considerations*. Retrieved December 30, 2003, from http://www-unix.oit.umass.edu/~ aizen/publications.html

Altenbaugh, R.J. (Ed). (1999). *Historical dictionary of American education*. Westport, CT: Greenwood Press.

American Association for the Advancement of Science (AAAS). (1993). *About benchmarks.* Retrieved November 13, 2005, from http://www.project2061.org/publications/bsl/online/bchin.htm

American Association for the Advancement of Science (AAAS). (2005). *About Project 2061.* Retrieved November 13, 2005, from http://www.project2061.org/about/default.htm

American Association for the Advancement of Science (AAAS). (2006). *Benchmarks for science literacy.* Retrieved March 9, 2007, from http://www.project2061.org/publications/bsl/default.htm

Atkin, J.M., & Black, P. (2007). History of science curriculum reform in the United States and the United Kingdom. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp.781-806). Mahwah, NJ: Lawrence Erlbaum Associates.

Bacharach, V.R., Baumeister, A.A., & Furr, R.M. (2003). Racial and gender science achievement gaps in secondary education. *Journal of Genetic Psychology, 164*(1), 115-127.

Balas, A.K. (1998, updated 2003). *Science fairs in elementary school*. (ERIC Document Reproduction Service No. ED 432444)

Baldi, S., Jin, Y., Skemer, M., Green, P.J., and Herget, D. (2007). *Highlights From PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context* (NCES 2008–016). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Baker, D., & Leary, R. (1995). Letting girls speak out about science. *Journal of Research in Science Teaching*, *32*(1), 3. Retrieved from Education Research Complete database.

Bellipanni, L.J. (1994). *The science fair experience: Profile of science fair winners* (Tech. Rep. No 143). Mississippi: Mississippi State. (ERIC Document Reproduction Service No. ED 395793)

Bellipanni, L.J., & Lilly, J.E. (2003). What have researchers been saying about science fairs? In *Science fairs plus: Reinventing an old favorite, K*-8 (pp.30-35). Arlington, VA: NSTA Press.

Benenson, J.F., Roy, R., Waite, A., Goldbaum, S., Linders, L., & Simpson, A. (2002). Greater discomfort as a proximate cause of sex differences in competition. *Merrill Palmer Quarterly, 48*(3), 225-247.

Berlin, D.F., & Kumar, D.D. (1993). *The status of STS implementation in the United States and its implications*. Atlanta, GA: (ERIC Document Reproduction Service No. ED361186)

Berns, B.B., Kantrov, I., Pasquale, M.,Mankang, D.S., Zubrowski, B., Goldsmith, L.T., et al. (2003). *Guiding curriculum decisions for middle-grades science abridged and updated: A quick reference guide for educators.* Newton, MA: Education Development Center, Inc.

Beyer, L.E. (1985). Educational reform: The political roots of national risk. *Curriculum Inquiry, 15*(1), 37-56.

Blanchard, C. W. (1989). *The developmental aspects and origins of competitive behavior in children*. New Mexico: New Mexico State University. (ERIC Document Reproduction Service No. ED325260)

Blenis, D.S. (2000). *The effects of mandatory, competitive science fairs on fifth grade students' attitudes toward science and interests in science.* Florida: Florida Institute of Technology. (ERIC Document Reproduction Service No. ED443718)

Bruce, S.P., & Bruce, B.C. (2000). Constructing images of science: People, technologies, and practices. *Computers in Human Behavior, 16*, 241-256.

Bunderson, E.D., & Anderson, T. (1996). Preservice elementary teachers' attitudes toward their past experiences with science fairs. *School Science & Mathematics, 96*(7), 371-378.

Bybee, R.W. (1995). *Science curriculum reform in the United States.* Retrieved November 14, 2005, from http://www.nas.edu/rise/backg3a.htm

Calsyn, C., Gonzales, P., & Frase, M. (1999). *Highlights from TIMSS; The third international math and science study.* (NCES Publication No. 1999-081). Washington, DC: U.S. Government Printing Office.

Cooney, S. (2000). *A middle grades message: A well-qualified teacher in every classroom matters*. Atlanta, GA: Southern Regional Education Board.

Czerniak, C.M. (1996). Predictors of success in a district science fair competition: An exploratory study. *School Science & Mathematics, 96*(1), 21-28.

Czerniak, C.M., & Lumpe A.T. (1996). Predictors of science fair participation using the theory of planned behavior. *School Science & Mathematics, 97*(7), 335-362.

DeBacker, T.K., & Nelson, R.M. (2000). Motivation to learn science: Differences related to gender, class type, and ability. *Journal of Educational Research, 93*(4), 245-254.

Dimitrov, D. M. (1999). Gender differences in science achievement: Differential effect of ability, response format, and strands of learning outcomes. *School Science & Mathematics, 99*(8), 445-450.

Gaskill, P.E. (2002). Progress in the certification of middle level personnel. *Middle School Journal, 33*(5), 33-40.

George, P. (2002). *No child left behind: Implications for middle level leaders.* Westerville, OH: National Middle School Association.

Gonzales, P., Calsyn, L., Jocelyn, L., Mak, K., Kastberg, D., Arafeh, S., Williams, T., & Tsen, W. (2000). *Highlights from TIMSS-R*. (NCES Publication No. 2001-027). Washington, DC: U.S. Government Printing Office.

Gonzales, P., Guzman, J.C., Partelow, L., Pahike, E., Jocelyn, L., Kastberg, D., & Williams, T. (2004). *Highlights from the Trends in International Mathematics and Science Study (TIMSS) 2003.* (NCES Publication No. 2005-005). Washington, DC: U.S. Government Printing Office.

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., and Brenwald, S. (2008). *Highlights from TIMSS 2007: Mathematics and Science Achievement of U.S. Fourth- and Eighth-Grade Students in an International Context.* (NCES 2009–001). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Grigg, W.S., Lauko, M.A., & Brockway, D.M. (2006). *The nation's report card: Science 2005.* (NCES Publication No. 2006466). Washington, DC: U.S. Government Printing Office.

Grote, M. (1995a). Science teacher educators' opinions about science projects and science fairs. *Journal of Science Teacher Education, 6*(1), 48-52.

Grote, M. (1995b). Teacher opinions concerning science projects and science fairs. *Ohio Journal of Science, 95*(4), 274-277.

Grote, M. (1996). The nature of student science projects in comparison to educational goals for science. *Ohio Journal of Science, 96*(4/5), 81-88.

Hines, E., & McMahon, M.T. (2005). Interpreting middle school students' proportional reasoning strategies: Observations from preservice teachers. *School Science & Mathematics, 105*(2), 88-106.

Hurd, P.D. (2000). *Transforming middle school science education*. New York: Teachers College Press.

Intel. (2005). *Five decades of brilliant thinkers*. Retrieved November 30, 2005, from http://www.intel.com/pressroom/kits/education/isef/isef_history_06.pdf

Intel. (2006a). *Intel international science and engineering fair 2006 fact sheet*. Retrieved July 30, 2006, from http://www.intel.com/pressroom/kits/education/isef/isef_factsheet_06.pdf

Intel. (2006b). *Top young scientists from around the world awarded $4 million in scholarships*. Retrieved July 30, 2006 from http://www.intel.com/pressroom/archive/releases/20060512edu.htm

Intel. (2006c). *Intel-ISEF affiliated fair judging criteria*. Retrieved July 30, 2007 from http://www.sciserv.org/isef/judges/judges_criteria.asp

Intel. (2008). *The 2008 Intel international science and engineering fair, 59 years of scientific excellence.* Retrieved April10, 2009 from http://www.intel.com/pressroom/kits/education/isef/isef_factsheet.pdf?iid = pr_smrelease_ISEF_rellinks1

Jackson, A. W., & Davis, G. A. (2000). *Turning points 2000: Educating adolescents in the 21st century*. New York & Westerville, OH: Teachers College Press & National Middle School Association.

Jackson, E.L. (1995). A comparison of 1994 Mississippi science fair winners and nonwinners at the local, regional, and state levels of competitions (Doctoral dissertation, Delta State University, 1995). *Dissertation Abstracts International,* 56-3A, 880.

Johnson, L. (2006). Elementary school students' learning preferences and the classroom learning environment: Implications for educational practice and Policy. *The Journal of Negro Education, 75*(3), 506-518.

Jones, M.G., & Carter, G. (2007). Science teacher attitudes and beliefs. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp.1067-1104). Mahwah, NJ: Lawrence Erlbaum Associates.

Junior Science and Humanities Symposium (JSHS). (2004). *What is JHSH?* Retrieved November 17, 2005, from http://www.jshs.org/about.html

Kahle, J.B., Parker, L.H., Rennie, L.J., & Riley, D. (1993). Gender differences in science education: Building a model. *Educational Psychologist, 28,* 379-404.

Kennedy, H.L., & Parks, J. (2000). Society cannot continue to exclude women from the fields of science and mathematics. *Education, 120(*3), 529-537.

Kliebard, H.M. (1995). *The struggle for the American curriculum.* New York: Routledge.

Kosick, L. (2009). [Pittsburgh regional science and engineering fair statistics]. Unpublished raw data.

Lee, M. (2007). Spark up the American Revolution with math, science, and more. *The Social Studies, 98*(4), 159-164.

Lee, O. & Paik, S. (2000). Conceptions of science achievement in major reform documents. *School Science and Mathematics, 100*(1), 16-26.

Lupart, J.L., Cannon, E., & Telfer, J. (2004). Gender differences in adolescent academic achievement, interests, values and life-role expectations. *High Ability Studies, 15*(1), 25-42.

Marshall, J.D., Sears, J.T., & Schubert, W.H. (2000). *Turning points in curriculum: A contemporary American memoir.* Upper Saddle River, NJ: Prentice-Hall, Inc.

McEwin, C.K., Dickinson, T.S., Erb, T.O., & Scales, P.C. (1995). *A vision of excellence: Organizing principles for middle grades teacher preparation.* Columbus, OH: National Middle School Association.

McLaughlin, M.W., Shepard, L.A., & O'Day, J.A. (1995). *Improving education through standards-based reform: A report by the National Academy of Education panel on standards-based education reform.* Stanford, CA: Stanford University, National Academy of Education.

McLeod, S., D'Amico, J.J., & Protheroe, N. (2003). *K-12 principals guide to No Child Left Behind.* Arlington, VA: Educational Research Service.

Medrich E.A., & Griffith, J.E. (1992). *International mathematics and science assessment: What have we learned?* (NCES Publication No. 92-011). Washington, DC: U.S. Government Printing Office.

Miller, P.H., Blessing, J.S., & Schwartz, S. (2006). Gender differences in high-school students' views about science. *International Journal of Science Education, 28*(4), 363-381.

Muller, P.A., Stage, F.K., & Kinzie, J. (2001). Science achievement growth trajectories: Understanding factors related to gender and racial-ethnic differences in precollege science achievement. *American Educational research Journal, 38*(4), 981-1012.

National Association of Elementary School Principals (NAESP), & National Association of Secondary School Principal (NASSP). (2003). *K-12 principals guide to No Child Left Behind.* Arlington, VA: Educational Research Service.

National Center for Education Statistics (NCES). (2006). *NAEP Overview*. Retrieved July 14, 2006, from http://nces.ed.gov/nationsreportcard/about/

National Center for Education Statistics (NCES). (2009). *Science the nation's report card.* Retrieved July 31, 2009, from http://nces.ed.gov/nationsreportcard/science/

National Center on Education and the Economy (NCEE). (2005). *Raise the benchmark with New Standards Products*. Retrieved August 3, 2006, from http://www.ncee.org/store/products/index.jsp?setProtocol= true&stSection= 1

National Commission on Excellence in Education. (1983a). *A nation at risk.* Retrieved November 14, 2005, from http://www.ed.gov/pubs/NatAtRisk/risk.html

National Commission on Excellence in Education. (1983b). *Recommendations.* Retrieved November 14, 2005, from http://www.ed.gov/pubs/NatAtRisk/recomm.html

National Forum to Accelerate Middle Grades Reform. (2002). *National Forum policy statement: Teacher preparation, licensure, and recruitment policy*. Newton, MA: Education Development Center.

National Middle School Association (NMSA). (1991). *Professional certification and preparation for the middle level: A position paper of the National Middle School Association*. Columbus, OH: Author.

National Middle School Association (NMSA). (2003). *This we believe:* Successful schools for young adolescents. Columbus, OH: Author.

National Middle School Association (NMSA). (2006). *About NMSA.* Retrieved November 27, 2007, from http://www.nmsa.org/AboutNMSA/tabid/76/Default.aspx

National Research Council (NRC). (1995). *National science education standards*. Washington, DC: National Academy Press.

National Science Foundation (NSF). (2005). *An overview of the first 50 years*. Retrieved November 11, 2005, from http://www.nsf.gov/about/history/overview-50.jsp

National Science Teachers Association (NSTA). (1999). *NSTA position statement: Science competitions.* Retrieved December 30, 2003, from http://www.nsta.org/159&psid= 3

National Science Teachers Association (NSTA). (2006). *NSTA's Mission.* Retrieved July 1, 2003, from http://www.nsta.org/aboutnsta

The New-York Historical Society. (2002). *Guide to the records of the American Institute of the City of New York for the encouragement of science and invention1808-1983 (Bulk 1828-1940).* Retrieved August 10, 2005, from http://dlib.nyu.edu:8083/nyhsead/servlet/SaxonServlet?source= /american inst2.xml&style= /saxon01n2002.xsl&part= body#series2

No Child Left Behind Act of 2001, Pub. L. No. 107-110. 115 Stat.1425 (2002).

Olsen, L.S. (1985). *The North Dakota science and engineering fair-its history and a survey of participants*. Unpublished master's thesis, North Dakota State University of Agriculture and Applied Science, Fargo, North Dakota.

Ornstein, A.C., & Hunkins, F.P. (1998). *Curriculum foundations, principles, and issues.* Needham Heights, MA: Allyn and Bacon.

Owens, L. (1985). The learning preferences of students and teachers: An Australian-American comparison, *Teaching & Teacher Education, 1*(3), 229-241.

Owens, L., & Barnes, J. (1992). *Learning preference scales: Handbook and test master set.* Australia: ACER.

Pennsylvania Department of Education (PDE). (2005). *Public, private and nonpublic schools enrollment 2004-05.* Retrieved June 1, 2007, from http://www.pde.state.pa.us/k12statistics/lib/k12statistics/P&PNPEnroll04 05Rev3.pdf

Pennsylvania Department of Education (PDE). (2006). *Academic standards for science and technology.* Retrieved June 1, 2006, from http://www.pde.state.pa.us/k12/lib/k12/scitech.pdf

Pennsylvania Department of Education (PDE). (2008a). *Public schools enrollments 2007-08.* Retrieved April 6, 2009, from http://www.pde.state.pa.us/k12statistics/cwp/view.asp?a=3&Q=125758&k12statisticsNav=|5367|&k12statisticsNav=|

Pennsylvania Department of Education (PDE). (2008b). *Private and nonpublic schools enrollment 2007-08.* Retrieved April 6, 2009, from http://www.pde.state.pa.us/k12statistics/cwp/view.asp?a=3&Q=146975

Pennsylvania Department of Education (PDE). (2009). *2007-2008 PSSA and AYP Results.* Retrieved April 6, 2009, from http://www.pde.state.pa.us/a_and_t/cwp/view.asp?A=3&Q=146079

Pennsylvania Junior Academy of Science (PJAS). (2003). *Short history of the Pennsylvania Junior Academy of Science.* Retrieved November 30, 2005, from http://pjas.net/pjas_info.php?PHPSESSID=7f8d60d9fae0b7963131afa0b98565df

Pennsylvania Junior Academy of Science (PJAS) Region 7. (2005). *About PJAS.* Retrieved November 30, 2005, from http://pjas7.org/index.php?module= pagemaster&PAGE_user_op= view_page&PAGE_id= 3&MMN_position= 3:3

Pennsylvania Junior Academy of Science (PJAS) Judging Committee. (2008, September). *Data from the state competition.* Paper presented at the meeting of the Pennsylvania Junior Academy of Science Fall Director's Meeting, State College, PA.

Petzko, V. N. (2002, November). *Teachers in the middle level schools: Implications and recommendations from a national study.* Paper presented at the annual meeting of the Mid-South Educational Research Association, Baton Rouge, LA.

Postlethwaite, T.N., & Wiley, D.E. (Eds.). (1992). *The IEA study of science II: Science achievement in twenty-three countries.* Oxford: Pergamon Press.

Rosier, M.J., & Keeves, J.P. (Eds.). (1991). *The IEA study of science I: Science education and curricula in twenty-three countries.* Oxford: Pergamon Press.

Schneider, R.M., & Lumpe, A.T. (1996). The nature of student science projects in comparison to educational goals for science. *Ohio Journal of Science, 96*(4/5), 81-88.

Science Service. (2003). *80 years in the service of science*. Retrieved August 5, 2005, from http://www.sciserv.org/history.asp

Science Service. (2006a). *Intel science talent search 2007 facts and instructions*. Retrieved July 30, 2006, from http://www.sciserv.org/sts/entrybk.pdf

Science Service. (2006b). *2007 affiliated fair information*. Retrieved December 30, 2006, from http://www.sciserv.org/isef/aff_fairs/fairlist/pennsylv.asp

Shakeshaft, C. (1995). Reforming science education to include girls. *Theory Into Practice, 34*(1), 74-79.

Shore, B.M., & Delcourt, M.A.B. (1995, November). Understanding inquiry: Lessons in scientific thinking and fraud from students' participation in science fairs. Paper presented at the annual meeting of the National Association for Gifted Children, Salt Lake City, UT.

Siemens Corporation. (2005). *The competition process*. Retrieved October 1, 2006, from http://www.siemens-foundation.org/competition/process.htm

Silverman, M.B. (1986). Effects of science fair projects involvement on attitude of New York City junior high school students. *Dissertation Abstracts International, 47,* 142A.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest and academic engagement. *The Journal of Educational Research, 95*(5), 323-332.

Society for Science and the Public (SSP). (2008). SSP Middle School Program History. Retrieved April 11, 2008 from http://www.societyforscience.org/msp/background.asp

Syer, C.A., & Shore, B.M. (2001). Science fairs: What are the sources of help for students and how prevalent is cheating? *School Science & Mathematics, 101*(4), 206-221.

Tolley, K. (2003). *The science education of American girls.* New York: Routledge Farmer.

Trumball, D.J., Scarano, G., & Booney, R. (2006). Relations among two teachers' practices and beliefs, conceptualizations of the nature of science, and their implementation of student independent inquiry projects. *International Journal of science education, 28(*14), 1717-1750.

Van Eck, R. (2006). The effect of contextual pedagogical advisement and competition on middle-school students' attitude toward mathematics and mathematics instruction using a computer-based simulation game. *Journal of Computers in Mathematics and Science Teaching, 25*(2), 165-195.

Vars, G.F. (1997). Effects of integrative curriculum and instruction. In J.L. Irvin (ed.), *What current research says to the middle level practitioner* (pp.179-186). Columbus, OH: National Middle School Association.

Wang, X.H., & Yang, B.Z. (2003). Why competition may discourage students from learning? A behavioral economic analysis. *Education Economics, 11*(2), 117-128.

Wilson, J.D., Cordry, S., Uline, C. (2004). Science fairs: Promoting positive attitudes towards science from student participation, *College Student Journal, 38I*(1), 112-115.

Wilson, J.H. (2006). Predicting student attitudes and grades from perception of instructors' attitudes. *Teaching of Psychology, 33*(2), 91-95.

Wiygul, S.M., & Gifford V.D. (1987). The effects of the use of outside facilities and resources on success in secondary school science fairs. (ERIC Document Reproduction Service no. ED288749)

Yasar, S., & Baker, D. (2003, March). *The impact of involvement in a science fair on seventh grade students.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, Philadelphia, PA.

Appendix A

Permission Granted to Use Science Fair Survey

From: mgrote@columbus.k12.oh.us
Sent: Tuesday, October 26, 2004 8:18 AM
To: Laura/Basil Fisanick
Subject: Re: dissertation permission request for survey

I tend to agree. I am working on science fairs here in Columbus, but we are working with high school students only.

You have permission to use anything you wish from the article.

Dr. Michael Grote
Department of Mathematics and Science Curriculum and Instruction
Columbus Public Schools
6655 Sharon Woods Blvd.
Columbus, OH 43229
phone: (614) 365-8661
fax: (614) 365-5027

Step Up and Make It Happen: World Class Student Achievement in Mathematics and Science
"Laura/Basil Fisanick" < fisanick@helicon.net>

Hello Dr. Grote,

I am a middle school science teacher in a rural western Pennsylvania school district and I am currently working on my doctorate in Curriculum and Instruction from the Indiana University of Pennsylvania.

I am very involved with the science fairs in the region including the Pennsylvania Junior Academy of Science and the Pittsburgh Regional Science and Engineering Fair. Therefore, my dissertation topic is Middle School Science Teachers' Perceptions of Competitive Science Fairs. Specifically, I hope to find a reason behind the intense support by teachers of science fairs at the middle school level when research has shown that competitive science fairs may not be developmentally appropriate for adolescents. I believe a possible reason may be due to the competitive nature of the science teacher.

I would like to ask permission to use several questions from a survey of yours found in the article, "Teachers Opinions Concerning Science Projects and Science Fairs", Ohio Journal of Science 95(4), 274-277.

Thank you

Respectfully,
Laura Fisanick
Cambria Heights Middle School
414 Glendale Lake Road
Patton, Pa 16668
814-674-6290 ext 216

Appendix B

Purchase Record of LPST Survey

ABN: 19 004 398 145

Head Office:	ACER Press
19 Prospect Hill Road Camberwell VIC 3124 AUSTRALIA Tel: + 61 3 9277 5555 Fax: + 61 3 9277 5500 Enquiry: info@acer.edu.au	347 Camberwell Road Camberwell VIC 3124 AUSTRALIA Tel: + 61 3 9835 7447 Fax: + 61 3 9835 7499 Email: sales@acer.edu.au

Receipt of Order	
Order No:	31953
Order Date:	26-10-2004 10:42:00

Section A: Customer Details

Bill To:	Deliver To:
Name: Laura Fisanick **Organisation:** **Tax Invoice/Receipt Recipient:** Laura Fisanick **Purchase Order No. (if applicable):** **Account No:** **Address:** 156 FISANICK LANE PO BOX 10 **Postcode:** 15762 **Contact Tel:** 8149489503 **Fax:** **Email:** fisanick@helicon.net	**Name:** **Organisation:** **Street Address:** **Postcode:** **Tel:** **Fax:**

Section B: Order Details

Code	Component Name	Unit Price	Qty	Total
A131BK	Learning Preference Scales	65.95	1	65.95
FREIGHT	Freight Charges	16.49	1	16.49
			Total Price including GST: (AUD$)	82.44

Thank you NOTE: This is a Receipt of Order only. Tax Invoice will be sent to you with your order. Please print this for your reference.

Back to ACER

INFORMATION DISCLAIMER

Appendix C

Site Permission Request Granted

Directors' Meeting
Nittany Lion Inn
Penn State University

Pennsylvania Junior Academy of Science Directors Meeting
Penn State University
State Meeting

October 1, 2004

1. **Pete Carando called the meeting to order at 8pm. Present at the meeting were the following:**

Pete Carando	Rebecca Papson	Leah Ann Williams
Juanita Allison	Dori Lijewski	Donald Kieffer
Stephen Hiner	Duane Keenan	James Conlin
Alice Sebra	Dr. Sue Johnston	Jane Huffman
Dominic Fedele	Anthony Podczasy	Fred Brenner
Ellen Chapman	Edith Mauthe	Debbie Lindsay
Robert Everly	William Levan	Laura Fisanick
Helen Wicker	Raymond Greco	Becky Sheridan
Donna Nunamaker	Fay Nelson	Jeff Keenan
Joseph Durkin	James Maloy	Stanley Tracton
Dr. William Uricchio	Kathy Durkin	Dr. Marlene Cross
Chriss Schultz	Hank McCollum	Clay La Coe
Amy Carando		

17. New Business
Laura Fisanick is working toward her doctorate degree. She will distribute a survey to be given out at the regional Sunday meeting. The survey involves middle school teachers only.

18. Science Talent Search
Dr. Cross distributed the Pennsylvania Talent Search Forms. The directors filled out the form on who is responsible for the talent search for their regions. Dr. Cross said the regions may choose between two interview forms. She will need a list of the judges from the regions. For each student Dr. Cross will need interview forms, copies of transcripts with either SAT or PSAT scores and one letter of recommendation.

20*. State Director Term*
Pete reminded all present that this was his 3rd year as state director.

Joe Durkin made a motion to adjourn. Tony Podczasy seconded. All approved.
The meeting was adjourned.

Respectfully submitted,
Rebecca Papson
Rebecca Papson
State Secretary

Appendix D

Informed Consent Form

Dear Middle School Science Teachers,

You are invited to participate in this research study. The following information is provided for you to help you make an informed decision as to whether or not you wish to participate.
The purpose of this study is to encourage middle school science teachers to reflect upon their current classroom practices when preparing students for Science Fair competitions. This teacher reflection will hopefully improve Science Fair experiences for both teachers and students. To determine the degree of teacher reflection necessary, this study will survey science teacher preference for different classroom student learning modes (cooperative, competitive, individualistic) as identified by Owens and Barnes (1992) and will survey science teacher attitudes regarding Science Fair competitions.
Middle school science teachers who encourage student Science Fair projects that are experimental, involve cooperative learning, and provide curriculum integration employ developmentally appropriate practices in their classrooms (Wilson & Horch, 2004). After student completion of the Science Fair project most science teachers require students to participate in science fair competitions (Abernathy & Vineyard, 2001; Bunderson & Anderson, 1996; Czerniak, 1996; Czerniak & Lumpe, 1996). Competitions may not developmentally appropriate for middle school students. Both the National Science Teachers Association (1991) and the National Middle School Association (1995) advise against compulsory student participation in competitions.

Participation in this study involves a 15 minute survey that will require you to:

1. Complete a demographic information chart pertaining to you, to your students who participate in Science Fair competitions, and to your school district.
2. Answer 13 questions using a Likert scale to identify your attitudes regarding Science Fair projects and competitions.
3. Answer 33 questions using a Likert scale to determine your preferences for and evaluation of three different classroom learning modes for students.

Participation in this study is <u>voluntary</u>. Participation or non-participation in this research study will in no way affect your relationship with the Pennsylvania Junior Academy of Science or its members. If you choose to participate, all information provided will remain anonymous and confidential and no individual data will be shared with the Pennsylvania Junior Academy of Science organization. No known risks are associated with this research study.
All participants will receive an executive summary via email. If you are willing to participate in this study, please complete the Voluntary Consent Form. Deposit the Voluntary Consent Form along with the completed survey in the designated box by the door. Please take this copy of the Informed Consent Form with you for your records. Additional copies of the Informed Consent Form are located near the deposit box. If you choose not to participate, deposit the unsigned Voluntary Consent Form and the uncompleted survey in the designated box by the door.
Your time and cooperation is very much appreciated.
Thank You,

Laura Fisanick

Laura Fisanick, Principal Investigator
Doctoral Candidate – Curriculum & Instruction
Indiana University of Pennsylvania

156 Fisanick Lane
Nicktown, PA 15762
Phone: (814) 948-9503
Email: Fisanick@helicon.net

Dr. Laurie Nicholson Stamp
Indiana University of Pennsylvania
Department of Professional Studies

303 Davis Hall
Indiana, Penna. 15705
(724) 357-2400
Email: lnstamp@iup.edu

<u>This project has been approved by the Indiana University of Pennsylvania Institutional Review Board for the Protection of Human subjects (Phone: 724-357-7730).</u>

Appendix E

Voluntary Consent Form

I have read and understand the information on this form and I consent to volunteer to be a subject in this study. I understand that my responses are completely anonymous and confidential. I have received an unsigned copy of this informed Consent Form to keep in my possession.

Name (PLEASE PRINT)	
Signature	
Date	
Phone number	
Email address	
Location where you can be reached	
Best days and times to reach you	

I certify that I, or my representative, have explained to the above individual the nature and purpose, the potential benefit and possible risks associated with participating in this research study, have answered any questions that have been raised, and have witnessed the signature above possession.

	Laura Fisanick
Date	Investigator's Signature

Date	Representative of Investigator's Signature

Appendix F
Demographic Information Survey

1. **School Type**

☐ Public ☐Private ☐Other

2. **Teacher Gender**

☐Male ☐Female

3. **Teacher Race**

☐White ☐Hispanic

☐Asian ☐AfricanAmerican

☐Latino/Latina ☐ Other _____

4. **Total Years Teaching**

☐1-5 years ☐6-10 years

☐10-15 years ☐15-20 years

☐20-25 years ☐25-30 years

☐Over 30 years

5. **Total Years Teaching Science**

☐1-5 years ☐6-10 years

☐10-15 years ☐15-20 years

☐20-25 years ☐25-30 years

☐Over 30 years

6. **Grade Levels Teaching Science**

☐Elementary ☐Post Secondary

☐Middle School ☐High School

☐Other___________

7. **Total Years of Your Participation in PJAS**

☐1-5 years ☐6-10 years

☐10-15 years ☐15-20 years

☐20-25 years ☐25-30 years

☐Over 30 years

8. **Is your participation as a PJAS sponsor voluntary?**

☐Yes ☐No

9. **On average, how many of your students receive 1st place in PJAS?**

☐1 ☐2 ☐3 ☐4

☐5 or more

10. **Do you require students to conduct individual Science Fair Projects?**

☐Yes (All Students)

☐Yes (Only Students who choose to participate.)

☐No ☐Other (Explain)

11. **Do you require students to complete in Science Fair competitions beyond the local school level?**

☐Yes (All Students)

☐Yes (Only Students who choose to participate.)

☐No ☐Other (Explain)

12. **Were you required by your school district to have students participate in the PJAS Science Fair competition?**

☐Yes ☐No

13. **Did you want to be a sponsor for the PJAS Science Fair competition?**

☐Yes ☐No

14. **Does your school district provide monetary compensation for sponsoring students in PJAS?**

☐Yes ☐No

15. **If compensated, how much per year?**

$_____________

16. **How much total time do you spend preparing students for PJAS?**

☐0 Hours ☐50-100 Hours

☐Less than 50 Hours ☐More than 50 Hours

Appendix G

Science Fair Survey

Michael Grote Department of Education, Ohio Wesleyan University, 1995

DIRECTIONS

Place a mark in the box that corresponds to your answer for each question.

If you *strongly disagree* ***with the question, mark the column on the*** *far right.*		Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1.	Science fairs are an outdated idea and have no value in the science programs of modern schools.				√

If you *moderately disagree* ***with the question, mark the column*** *2nd from the right.*		Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1.	Science fairs are an outdated idea and have no value in the science programs of modern schools.			√	

If you *strongly agree* ***with the question, mark the column on the*** *far left.*		Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1.	Science fairs are an outdated idea and have no value in the science programs of modern schools.	√			

If you *moderately agree* ***with the question, mark the column*** *2nd from the left.*		Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1.	Science fairs are an outdated idea and have no value in the science programs of modern schools.		√		

Appendix G

SCIENCE FAIR SURVEY					
		Strongly Agree	Moderately Agree	Moderately Disagree	Strongly Disagree
1.	Science fairs are an outdated idea and have no value in the science programs of modern schools.				
2.	Large cash and scholarship awards detract from the real purposes of science fairs.				
3.	Science fairs promote interest and enthusiasm about science.				
4.	Science fairs provide an opportunity for students to learn about the research of their fellow students.				
5.	Independent science research projects are valuable, but judging them in a science fair setting is counterproductive.				
6.	The opportunity to explain one's research to an outside observer (judge) enhances a student's interest in the research he/she has done.				
7.	Science fairs give students valuable experience in communication skills.				
8.	Science fairs put too much pressure on students.				
9.	The quality of judging at science fairs is generally good.				
10.	Science fairs are a logical evaluation tool for *standards*-based education.				
11.	Science fairs give interested students an opportunity to interact with other students who are interested in science.				
12.	Science fair judges should be trained or certified.				
13.	If my district did not require participation, I would not involve my students in science fair competitions.				

Appendix H

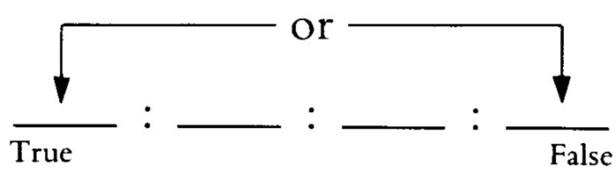
Learning Preference Scale – Teachers Survey

Lee Owens, Jennifer Barnes, Ralph Straton
School of Teaching and Curriculum Studies,
University of Sydney, 1990

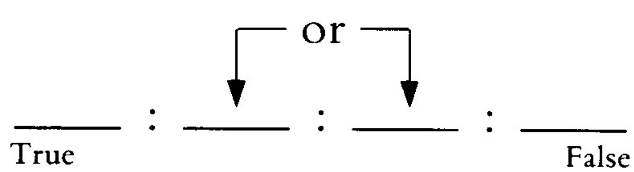
DIRECTIONS

Each of the 33 items is a statement that a teacher has made about learning. You will note some similarities in the way items are written. Despite this, each item actually refers to a different aspect of learning in the classroom. Please respond to each one independently.

There are no right or wrong answers. If the statement is clearly true for you, check the space *at the* **True** *end* of the answer line. If it is false for you, check the *space at the* **False** *end* of the answer line.



If it is a bit more true that false ('sort of true'), check the *inner space at the True end*; if it is a bit more false than true ('sort of false'), *check the inner space at the False end*.



For a number of statements it may be possible to say 'well, it all depends on...'. Please go past that reaction to an opinion that seems true for you most of the time.

Answer each item – leave no blanks.

Appendix H
Learning Preference Scale – Teachers Survey

1.	I enjoy a class where students work together to solve problems.	____ True	____	____	____ False
2.	Generally, students are keen to see who is best in tests in schoolwork.	____ True	____	____	____ False
3.	When students are programmed by the teacher in individual and independent learning, each one achieves well.	____ True	____	____	____ False
4.	Students working on their own most of the time become lonely and unhappy.	____ True	____	____	____ False
5.	Everyone benefits when the bright students assist the less able students in their work.	____ True	____	____	____ False
6.	The effect on a student of trying to do better than others is a concern to the teachers.	____ True	____	____	____ False
7.	Students learn best when they can learn at their own speed.	____ True	____	____	____ False
8.	A student who works and progresses independently in class is learning a highly useful skill for work and family life later.	____ True	____	____	____ False
9.	Arranging group work in the classroom is the best way for a teacher to learn about students' individual differences in abilities.	____ True	____	____	____ False
10.	Recognition for the individual students with the good ideas is more important than to give credit to a complete group or committee for good work.	____ True	____	____	____ False
11.	Students often produce more new ideas when they work on their own than when they work in other ways.	____ True	____	____	____ False
12.	I like a class where everyone is trying to do better than someone else.	____ True	____	____	____ False
13.	Generally, students prefer to work on their own without paying much attention to other students.	____ True	____	____	____ False
14.	When students in a classroom strive to see who is best, the quality of the work is generally very good.	____ True	____	____	____ False

Appendix H

15.	The quality of the work suffers when students work in groups.	True ____ : ____ : ____ : ____ False
16.	When students choose to compete against each other, the winners and the losers benefit from the experience.	True ____ : ____ : ____ : ____ False
17.	It is difficult for the teacher to conduct a class so that each student is satisfied working independently.	True ____ : ____ : ____ : ____ False
18.	When a group of students are trying to beat each other, most of them learn fast.	True ____ : ____ : ____ : ____ False
19.	What students learn from working together is especially useful training for work and family life later.	True ____ : ____ : ____ : ____ False
20.	Ranking students by means of tests is the best way for a teacher to learn about students' individual differences in abilities.	True ____ : ____ : ____ : ____ False
21.	Students do not need to know what other students are working on or how they are going in class.	True ____ : ____ : ____ : ____ False
22.	I prefer a class where each student works individually on a personally appropriate task.	True ____ : ____ : ____ : ____ False
23.	Generally, students enjoy helping each other discuss and understand the work.	True ____ : ____ : ____ : ____ False
24.	A group decision is usually more thoroughly considered than an individual one.	True ____ : ____ : ____ : ____ False
25.	When students concentrate on being better than others, they don't do as well as they might by working in other ways.	True ____ : ____ : ____ : ____ False
26.	When a group or class needs something important done, each student can help most by working it out alone.	True ____ : ____ : ____ : ____ False
27.	The noise and confusion involved in using group work can easily create problems for the teacher.	True ____ : ____ : ____ : ____ False
28.	When the class is divided into working groups, individual students learn the material quickly.	True ____ : ____ : ____ : ____ False

Appendix H

29.	A student who tries to come first in schoolwork is learning a particularly useful skill for work and family life later.	____ : ____ : ____ : ____ True False
30.	Setting personal work for each student to do independently is the best way for a teacher to learn about student's difference in abilities.	____ : ____ : ____ : ____ True False
31.	Students generally benefit from sharing and combining their ideas with others in the class.	____ : ____ : ____ : ____ True False
32.	It is important for each student to have the chance to be better than the others and win at something in class.	____ : ____ : ____ : ____ True False
33.	In small group work in class, the group discussions get on to the really important ideas.	____ : ____ : ____ : ____ True False

Please check to see that you have answered each question.

Thank you for taking the time to complete this.

Appendix I

Reminder Sign Used at Testing Sites

PLEASE
take a copy of this Informed Consent Form for your records.

LEARNING PREFERENCE SCALE — TEACHERS

Personal Feedback Form

Scoring the LPST

1. Most items are scored 4–3–2–1 from left to right.

4	3	2	1
True			False

2. Some items are phrased in the negative, for these items only, reverse the direction of the scoring to 1–2–3–4.

1	2	3	4
True			False

In the LPST, these items are **4**, **6**, **15**, **17**, **25**, **27**. *Score these items first*, then score the remainder.

3. 'Add up' the item scores in three sets.

Cooperative Preference	Competitive Preference	Individualised Preference
1. ____	2. ____	3. ____
5. ____	**6.** ____	**4.** ____
9. ____	10. ____	7. ____
15. ____	12. ____	8. ____
19. ____	14. ____	11. ____
23. ____	16. ____	13. ____
24. ____	18. ____	**17.** ____
27. ____	20. ____	21. ____
28. ____	**25.** ____	22. ____
31. ____	29. ____	26. ____
33. ____	32. ____	30. ____
TOTAL ____	____	____

Interpreting the LPST scores

The following tables from a major study with New South Wales teachers may assist you to understand your own scores.

Quartile table (LPST) for teachers in sex groupings (New South Wales)

	Coop.	Comp.	Ind.
Male	n = 281		
25th percentile	29	25	24
50th percentile	32	29	26
75th percentile	34	33	30
Mean	32.2	29.4	26.8
SD	4.27	5.62	3.85
Female	n = 335		
25th percentile	31	22	25
50th percentile	34	26	27
75th percentile	37	31	30
Mean	33.9	26.4	27.3
SD	4.35	5.32	3.70

Coop. = Cooperation Comp. = Competition
Ind. = Individualism

Quartile table (LPST) for teachers in main subject groupings (New South Wales)

	Coop.	Comp.	Ind.
Infants	n = 64		
25th percentile	33	22	25
50th percentile	36	24	28
75th percentile	38	28	31
Mean	35.9	24.5	28.4
SD	3.78	4.64	4.28
Primary	n = 85		
25th percentile	32	23	24
50th percentile	34	26	27
75th percentile	37	31	30
Mean	34.7	27.1	27.3
SD	3.71	5.54	3.78
Humanities	n = 186		
25th percentile	29	22	25
50th percentile	33	26	28
75th percentile	34	30	29
Mean	32.5	26.6	27.4
SD	4.05	5.38	3.53
Science/Maths	n = 132		
25th percentile	28	25	23
50th percentile	31	29	26
75th percentile	34	33	29
Mean	31.7	29.6	26.4
SD	4.77	6.12	3.72
Social sciences	n = 98		
25th percentile	29	25	24
50th percentile	32	29	26
75th percentile	36	32	29
Mean	32.8	28.9	26.9
SD	4.54	5.03	3.84

Appendix K

LPST Percentile Table – Reference Group Data

Table A13 Percentile table (LPST) for all teachers, New South Wales, United States and England separately

Score	NSW (n = 619)			USA (n = 342)			England (n = 278)		
	Coop.	Comp.	Ind.	Coop.	Comp.	Ind.	Coop.	Comp.	Ind.
40–44	96			94			93		
39	93			91			89		
38	90			86			85		
37	84	95		80			77		
36	77	94		72			67		
35	72	92		63	96		58		
34	62	90		54	94		49	95	
33	52	84	95	44	92	96	40	92	
32	44	80	93	35	89	95	35	89	
31	35	73	88	25	86	91	29	86	94
30	27	67	81	18	81	87	23	81	90
29	21	62	74	13	76	76	19	78	87
28	14	55	64	8	68	66	12	74	77
27	9	48	54	5	62	56	9	66	63
26	5	40	43	4	54	44	5	59	51
25	4	35	33		48	34	4	53	42
24		31	24		39	28		47	31
23		24	17		32	21		37	25
22		18	11		25	15		31	17
21		15	8		20	9		26	12
20		11	5		17	6		20	7
19		6			15	4		16	3
18		4			12			13	
17					8			9	
11–16					4			6	
Mean	33.1	27.8	27.1	34.1	25.8	26.7	34.1	25.3	26.0
SD	4.38	5.66	3.77	4.06	5.43	3.86	4.47	5.61	3.57

Coop. = Cooperation Comp. = Competition Ind. = Individualism