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A Study of Secondary Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms

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A STUDY OF SECONDARY SCIENCE TEACHER EFFICACY AND LEVEL OF CONSTRUCTIVIST INSTRUCTIONAL PRACTICE IMPLEMENTATION IN WEST VIRGINIA SCIENCE CLASSROOMS

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DEDICATION

This work is dedicated to my grandparents, James and Eva Coleman who have tirelessly encouraged my pursuit of higher education, though neither had the opportunity to pursue it themselves. Both attended school in grades 1-8 in the one-room school houses of Putnam County. My grandmother's formal education ended after grade eight as she was not able to attend high school due to lack of bus routes in the area and no funding to allow her to board in town. My grandfather began high school but was drafted into the Korean War before completing his senior year. Despite these hardships the importance of education was impressed upon them at a young age and they have supported the efforts of their family members to pursue life-long learning. Without their support this work would not have been possible.

This work is also dedicated to my parents, Edward and Patricia Knapp, whose support of education is an inspiration. Their hardworking example and devotion to the cause of education have inspired both their biological children and the students of Leon Elementary School, where they worked for many years as custodian and secretary, to pursue their dreams.

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ABSTRACT

The purpose of this study was to investigate the level of use of selected constructivist instructional practices and level of teacher efficacy in West Virginia secondary science classrooms. The study next sought to determine if a relationship existed between level of use of the constructivist practices and teacher efficacy. In addition the study sought to determine if differences existed in level of use of the selected constructivist practices and/or teacher efficacy based on selected demographic variables.

The study was a mixed-methods design. First, a researcher-developed survey instrument was used to collect data regarding the level of use of constructivist instructional practices. Efficacy data were collected using an adapted (with permission) version of the *Teacher Self-Efficacy Scale (TSES)* by Tschannen-Moran, Hoy, and Hoy (1998). The study population consisted of secondary science teachers (middle, junior, and high school) in the state of West Virginia. The last survey question allowed educators to volunteer for a short follow-up interview to clarify the quantitative data.

Overall, West Virginia science teachers reported frequent use of the selected constructivist instructional practices. Few significant differences were found based on the selected demographic variables. West Virginia science teachers reported moderately high efficacy levels. Few significant differences were found based on selected demographic variables. A moderate but significant correlation was found between teacher efficacy level and the level of use of the selected constructivist practices. The follow-up interviews clarified concepts and revealed barriers to implementation of new practices in the science classroom.

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CHAPTER 1: INTRODUCTION

Teacher efficacy and implementation of appropriate teaching practices play critical roles in the classroom and can have a powerful influence on student achievement. Nowhere is student achievement more important than in science classrooms. The National Research Council, National Science Teachers Association, American Association for the Advancement of Science, Achieve, and 20 participating states, including West Virginia, are in the process of creating Next Generation Science Standards (Next Generation Science Standards, 2011). These new standards must be implemented using appropriate constructivist instructional practices in order to improve student learning. Teacher efficacy level may play a significant role in the selection of instructional practices and ultimately the success of science teaching standards. Consequently, differences in level of teacher efficacy and level of use of selected constructivist instructional practices in the science classroom become paramount.

Increasing course rigor for all students is an integral part of enhancing science education for the 21st century, and the new standards strive to provide a rigorous, well rounded course experience by incorporating input from a diverse group of stakeholders: K-12 educators, higher education representatives, policy makers, the scientific community, and the business community (Next Generation Science Standards, 2011). With the creation of new standards, appropriate standards-based instructional practices must be chosen by science teachers. According to the National Science Teachers Association (NSTA), science instructors should incorporate a variety of instructional practices based on a constructivist theoretical framework to meet science standards (NSTA Position Statement: Leadership in Science Education, 2011).

As students from a variety of backgrounds and levels of preparedness enter the science classroom, the instructional practices used to reach students in the classroom may need to change. An increasingly diverse student population requires 21st century skill sets to be successful and competitive in the future. As student diversity and the demand for a more highly skilled workforce increase, educators must implement appropriate practices to meet student needs and rise to the challenge of providing students with science skills for success. It is necessary to understand current levels of constructivist practice implementation to determine how to proceed.

Educators have a broad range of instructional practices from which to choose (Paek, Ponte, Sigel, Braun, & Powers, 2005). Traditional behaviorist practices may not be appropriate for all subpopulations. The NSTA recommends the use of constructivist practices such as inquiry learning, problem solving, and cooperative leaning (NSTA Position Statement: Leadership in Science Education, 2011); however, all science educators may not believe constructivist practices are as effective as more traditional methods. In addition, teachers may feel they are unable to execute constructivist practices as well as those practices with which they have more experience. Therefore, in order to improve science instruction for modern demands, we need to determine current levels of use of constructivist instructional practices in science classrooms, current science teacher efficacy levels, and examine relationships between the two constructs.

Teacher efficacy is the teacher's belief in his/her ability to organize and implement actions in the classroom (Bandura, 1997). Therefore, teacher efficacy could play a significant role in the selection of instructional practices in the science classroom, which can significantly affect learning outcomes for various student populations. In addition, a sizeable population of low socioeconomic students (low SES) are part of the overall student demographic of the state and may require constructivist instructional practices for success. Teacher efficacy is positively correlated with instructional practice implementation in the classroom (Tschannen-Moran, Hoy, & Hoy 1998), and consequently student achievement. The results of a study of West Virginia science teachers' level of constructivist instructional practice implementation, and the relationship, if any, to teacher efficacy could be beneficial when choosing instructional practices to meet the standards and needs of a 21st century student population.

This study sought to determine current levels of implementation of selected constructivist instructional practices in West Virginia science classrooms, current levels of West Virginia science teacher efficacy, and the differences, if any, between teacher efficacy level and the level of use of selected constructivist practices. This information will provide educators with the knowledge to make sound decisions regarding instructional practices now and in the future

Issues in Science Education Today: Instructional Practices

Improving instructional practice can greatly improve student performance (Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook, & Landes, 2006). The authors stressed the importance of utilizing research-based practices in the classroom to facilitate student mastery of science content. The authors explained that practices must have certain characteristics to be successful in the science classroom. For example, practices must engage students in learning, build upon students' prior knowledge, have a relevant context and framework, and be organized appropriately. Ultimately these practices must lead students to define goals and monitor progress in attaining the goals. At the same time the instructor has great responsibility in choosing practices to support this learning. Teachers must accurately assess student needs and choose practices to support learning and challenge thinking. Subject matter must be taught in depth and misconceptions cleared up immediately via a focus on metacognitive skills (Bybee et al., 2006).

Barak and Shakhman (2007) examined issues in science instructional practices and found that "science teaching must be shifted from traditional schooling to more constructivist oriented instruction" (p. 11). The authors listed critical thinking, problem solving, independent study, and decision making as skills that must be fostered if science education is to meet student needs. The authors also listed inquiry learning, collaboration, and personal belief as components for successful learning in science.

Barak and Shakhman (2007) contrasted a constructivist instructional practice framework with a traditional approach. In the constructivist framework the instructor shares decision making, teaches students how to analyze their own thinking, and instructs in problem solving. In contrast educators from a traditional framework make the classroom decisions and focus on learning facts and principles.

Framework: Traditional and Constructivist Instructional Practices

Instructional practices play an important role in every classroom and influence student learning in a variety of ways. Paek et al., (2005) described successful teachers as those who utilize a variety of instructional practices. These practices can be classified into two basic categories: traditional and constructivist. According to the authors, traditional practices stem from a behaviorist theoretical framework which contrasts sharply with the constructivist framework. Because the selection of appropriate instructional strategies is critical for student success, it is important to understand and characterize both theoretical frameworks.

Behaviorism is a theoretical approach that focuses on observed behaviors with the goal of behavioral change (Woolfolk, 2010). Behavioral learning occurs when a behavior is strengthened or reinforced to encourage its utilization using a reward or other positive stimulus, or weakened to discourage utilization via a punishment or negative consequence. According to Woolfolk, examples of behaviorism in the classroom include the teacher providing instruction before an assignment, cueing, prompting, shaping, positive practice, reprimands, response costs, cautions, punishments, and social isolation. Emphasis is placed on learning a large amount of material. This theoretical approach results in a teacher-centered classroom utilizing practices such as direct instruction, lecture, teacher-led discussion, and assessment via multiple choice paper-pencil tests (Paek et al., 2005).

In contrast, the constructivist theoretical framework is student centered. Constructivist learning originates from the learner when the instructor provides a suitable learning environment to facilitate student-centered activities (Woolfolk, 2010). Learning is connected to prior knowledge with an emphasis on learning for the sake of learning. Reflection upon learning through writing, projects, portfolios, and other strategies is important.

Constructivism itself can be based upon the work of Piaget in which the focus lies on the psychology of the individual and his/her knowing, or based upon the work of Vygotsky with a focus on society/culture and skills developed through interaction within these structures (Woolfolk, 2010). Instructors are not the sole source of information and students are required to seek out knowledge and apply it for themselves. Bybee et al. (2006) also stressed the importance of John Dewey in the development of constructivist practices especially in the sciences. Dewey began his career as a science educator, and as such, promoted reflective thinking based on educational experiences such as hands-on labs and inquiry activities. Constructivist instructional practices such as cooperative learning, presentations and other performance-based assessments, portfolios/laboratory notebooks, writings, and independent research projects are utilized as a result of this framework (Paek et al., 2005).

The Face of West Virginia's Student Population

Each year the Anne E. Casey Foundation collects demographic data for each state regarding the condition of its children. As of 2011, the year for which the most recent data are available, WV had 384,794 citizens under age 18. Of these, 141,000 (37%) lived below 150% of the poverty line. In 2010 (the most recent data available) 53.5% of West Virginia's children were eligible for free or reduced lunch. In 2011 there were 32,000 single parent families below the poverty line in West Virginia, and 44,000 children considered to be living in extreme poverty (Anne E. Casey Foundation, 2012).

Many of these children of poverty live in homes where one or more parents work. In 2011 there were 95,000 West Virginia children in low income working families, and

92,000 West Virginia children were classified as low income with housing costs exceeding 30% of that income. In addition, 23,000 children were classified as living in crowded housing with 90,000 children suffering food insecurity in 2011. Such conditions can negatively affect children's health. As of 2007, the year for which the most recent data are available, 89,000 West Virginia children have special healthcare needs. As of 2009 there were 7.7 infant deaths per 1000 live births, 1,952 low birth weight babies, 313 very low birth weight babies, and 2,739 preterm births. As of 2007 11% of West Virginia's children had asthma (Anne E. Casey Foundation, 2012).

West Virginia student academic achievement is affected by low socioeconomic conditions. In 2011, 35% of eighth graders were below basic in math and 32% were below basic in reading. As of 2007 10% of children ages 1-5 were read to by family members less than three days a week. In 2009, the year for which the most recent data are available, there were 3,947 births to mothers with less than twelve years of education, and 5,616 births to mothers who smoked. There were also 560 births to women who received late or no prenatal care. In 2010 there were 26,000 West Virginia children (18 years old or below) without health insurance. In 2010 there were 17.6 reported cases of child abuse or neglect per 1,000 children in the state (Anne E. Casey Foundation, 2012).

Low SES students benefit from constructivist practices (Costello, Hollifield, & Stinnette, 1996). These authors suggested that students from low SES backgrounds and other at-risk populations benefit from the following practices: connecting learning to background and experiences, a variety of assessments that reflect multiple intelligences, emphasizing both higher order thinking skills and review of basics when necessary, belief in student ability, engaging activities, collaborative learning, connections with the community, avoidance of tracking, peer tutoring, questioning, allowing students to design and carry out their own experiments, and incorporating problem-based learning and reciprocal teaching.

Many studies found the same types of constructivist teaching methods to be beneficial to a variety of underserved populations (Costello, Hollifield, & Stinnette, 1996; Keller, 2005; McKinney, Flenner, Frazier, & Abrams, 2006). Educators must be aware of the student population demographics and the challenges they face if they are to select appropriate instructional practices to meet the needs of West Virginia science students, including the low SES subpopulation. The importance of constructivist instructional strategies for students is clear. However, what role does teacher efficacy play in educator utilization of these practices?

Teacher Efficacy

Teacher efficacy is described as a teacher's confidence in him/herself to promote student learning (Protheroe, 2008). Efficacy can be affected by prior teaching experience, training, and school culture and in turn influences teaching, instructor behavior, instructor attitude, and ultimately student outcomes (Bandura, 1993; Protheroe, 2008). Instructors with higher efficacy are more likely to be organized, plan more, try new programming, experiment, and are more willing to try new teaching practices to meet students' needs (Protheroe, 2008). Trying a new strategy when old ones are not sufficient directly influences student learning and holds important implications for instructing a variety of learners in the science classroom.

Efficacy is related to school climate, administrative support, sense of community, and decision-making structure (Tschannen-Moran, Hoy, & Hoy, 1998). The authors described two types of efficacy. Collective efficacy plays a role in how the staff works together and handles problems and/or change. Teacher efficacy can help mitigate the effects of certain student characteristics such as low SES. Stronger teacher efficacy may lead to stronger performance of low SES students even with many of the challenges already discussed. Unfortunately, the authors also reported that a low sense of efficacy can be contagious among staff members, undermining learning goals. If instructors do not believe an action will produce results in the classroom, they will not invest time, resources, or effort in the action (Bandura, 2002).

Teacher efficacy affects classroom behavior, teaching effort, and aspiration level (Tschannen-Moran, Hoy, & Hoy, 1998). The authors proposed that teachers with higher efficacy are more willing to implement new methods to meet student needs. In addition, they found that teacher efficacy changes with context and can be specific to content (science) and other situations. Efficacy can also change over time, especially in the initial years in the classroom, stabilizing thereafter.

Teacher efficacy is associated with student motivation, educator implementation of innovative ideas and techniques, classroom management, teaching time allotments, and student referral to special education (Woolfolk Hoy, 2000). According to the author, student teaching experiences and the initial teaching years are critical for strong efficacy development. Teacher efficacy may be formed through prior teaching experiences and events in classrooms unassociated with science coursework. These events influence an instructor's selection of teaching practices throughout the teaching career. Therefore a measure of teacher efficacy is a critical component of understanding the selection of instructional practices in science classrooms.

Teacher beliefs are important in the selection of instructional practices in the classroom (Albion, 1999). Beliefs are particularly important when considering implementation of new instructional practices. According to the author teacher belief can be flexible and applied to new situations, which will be the case as new standards are implemented in the science classroom.

Teacher efficacy has therefore become an important area of research in today's science classroom. One science teacher's belief about his/her ability to make a difference can have a profound effect upon dozens of students over the years. Consequently, this study examines teacher efficacy in relation to practice.

Statement of the Problem

Research indicates implementation of constructivist instructional practices as a powerful way to meet the needs of diverse science student populations, particularly West Virginia's large subpopulation of low SES students. In addition more efficacious science instructors are more likely to implement these constructivist strategies. However a discrepancy exists between research and practice. Appropriate instructional practices must be implemented to meet student needs. With the variety of instructional practices available, educators must select those they believe will be effective in the classroom. The selection of appropriate practices becomes more critical as Next Generation Science Standards are implemented. Because teacher efficacy level is so closely tied to level of implementation of instructional practices in science classrooms and, as a result, student outcomes, it is imperative to investigate differences between the two in West Virginia's science classrooms where the stakes are high for both students and staff.

This study investigated current levels of constructivist instructional practice implementation in West Virginia science classrooms, current science teacher efficacy levels, and the relationship, if any, between the two. Secondarily, the study sought to determine if there are any differences in the levels of constructivist practice implementation and teacher efficacy based on selected demographic/attribute variables.

Research Questions

The following research questions were utilized in the course of the study.

1. What are West Virginia science teachers' levels of use of selected constructivist instructional practices in West Virginia science classrooms?
2. What are the differences, if any, in the level of use of constructivist instructional practices based on selected demographic variables (years of teaching, Advanced Placement course instruction, SES level, class size)?
3. What are West Virginia science teachers' levels of efficacy regarding teaching science in WV science classrooms?
4. What are the differences, if any, in West Virginia science teacher efficacy levels for teaching science based on selected demographic variables (years of teaching, Advanced Placement course instruction, SES level, class size)?
5. What is the relationship, if any, between teacher efficacy level for teaching science and the use of selected constructivist instructional practices in West Virginia science classrooms?

Operational Definitions

During the course of this study the following operational definitions were used. The justification for use of these definitions is examined in chapter two.

-Total Teacher Efficacy Level for Teaching Science (TELTS) - Teacher's confidence in him/herself to promote student learning as measured by questions 1-24 on a modified version of a self-reported survey, the *Teacher Self-Efficacy Scale (TSES)* by Tschannen-Moran, Hoy, & Hoy (1998). The survey, contained in Part III of the instrument (Appendix A) consisted of a Likart scale of 1-9 with 1 being "Nothing" and 9 being "A Great Deal" resulting in an overall score.

-Teacher Level of Efficacy in Student Engagement (ESE) for Teaching Science – Teacher's confidence in him/herself to promote student learning through student engagement as measured by questions 1, 2, 4, 6, 9, 12, 14, and 22 on a modified version of a self-reported survey, the *Teacher Self-Efficacy Scale (TSES)* by Tschannen-Moran, Hoy, & Hoy (1998). The survey, contained in Part III of the instrument (Appendix A) consisted of a Likart scale of 1-9 with 1 being "Nothing" and 9 being "A Great Deal" resulting in the factor level analysis.

-Teacher Efficacy in Instructional Practices (EIP) for Teaching Science – Teacher's confidence in him/herself to promote student learning through selection of appropriate instructional practices as measured by questions 7, 10, 11, 17, 18, 20, 23, and 24 on a modified version of a self-reported survey, the *Teacher Self-Efficacy Scale (TSES)* by Tschannen-Moran, Hoy, & Hoy (1998). The survey, contained in Part III of the instrument (Appendix A) consisted of a Likart scale of

1-9 with 1 being "Nothing" and 9 being "A Great Deal" resulting in the factor level analysis.

-Teacher Efficacy in Classroom Management (ECM) for Teaching Science – Teacher's confidence in him/herself to promote student learning through classroom management as measured by questions 3, 5, 8, 13, 15, 16, 19, and 21 on a modified version of a self-reported survey, the *Teacher Self-Efficacy Scale (TSES)* by Tschannen-Moran, Hoy, & Hoy (1998). The survey, contained in Part III of the instrument (Appendix A) consisted of a Likart scale of 1-9 with 1 being "Nothing" and 9 being "A Great Deal" resulting in the factor level analysis.

-School Socioeconomic Status – Overall percentage of the student body qualifying for free and reduced lunch measured by self report question six on the Demographics section of the survey instrument (Appendix A). Respondents selected the category that best described the school in which they taught from the following list: less than 35%, 36-50%, 51-75%, and 76% or more.

-Total Level of Use of Constructivist Instructional Practices (TLCIP) – Teaching strategies derived from a constructivist theoretical framework (Woolfolk 2010) measured by self-reported responses on the *West Virginia Science Teacher Level of Constructivist Instructional Practice Survey* (*WVSTCIP*). The survey, contained in Part II of the instrument (Appendix A) consisted of a five point Likart scale for level of use with 1 being "Never Used" and 5 being "Very Frequently Used. "

-Total Years of Teaching Experience – The number of total years of full-time teaching the instructor had in the classroom. In this study it was measured by subject response to self-report question two in the Demographics section of the instrument (Appendix A). Respondents selected the best fit from the following categories: 5 or less, 6-10, 11-15, 16-20, 21-25, and 26+.

-Total Years of Teaching Science Courses – The total number of years of experience the instructor had teaching science courses. In this study it was measured by subject response to self-report question three in the Demographics section of the instrument (Appendix A). Respondents selected the best description from the following categories: 5 or less, 6-10, 11-15, 16-20, 21-25, and 26+.

-Class size – The total number of students in the average science classroom at the school. In this study it was measured by subject response to self-report survey question eight on the Demographics section of the survey instrument (Appendix A). Respondents selected the best description from the following categories: fewer than 10, 11-15, 16-20, 21-25, and 26 or more.

-School Level – Middle schools, junior high schools, or high schools in the state of West Virginia as defined by the West Virginia Secondary School Activities Commission (WVSSAC High School Classifications, 2011) school ranking system and measured by self-report question one on the Demographics section of the instrument (Appendix A). These schools included middle/junior high schools of grades 6-8, 7-8, and 6-9 and high schools of grades 9-12 and 10-12. Respondents selected the best description from the following categories: middle/junior high, high school, or both. Respondents who selected the "both" category were consolidated into the middle school category for statistical analysis.

-Subject(s) Taught in 2011-2012 - The subjects taught by respondents in the 2011-2012 school year as measured by self-report question four on the Demographics section of the survey. Respondents selected the best description from the following categories and were allowed to choose more than one category for a duplicated count: general science, chemistry, biological science, environmental/earth science, physical science, physics, or other.

-Advanced Placement Instruction – Instructors who taught one or more Advanced Placement (AP) courses in the past five years including the 2011-2012 school year as measured by self-report question five on the Demographics section of the survey. Respondents selected either "yes" or "no."

-School Size - The size of the school in which respondents taught in the 2011-2012 school year as defined by the WVSSAC (2011) school ranking system for 2011-2012 (A, AA, and AAA) . School Size was measured by self-report question seven on the Demographics section of the instrument (Appendix A). Respondents selected from the following categories: 339 or less, 340-618, and 619 or more.

Significance of the Study

The instructional practices selected by teachers play an important role in student success in the science classroom. Practice selection may be influenced by teacher efficacy. Instructors may choose to implement instructional practices in different levels dependent upon efficacy level. More research is needed to determine the relationships between the implementation of constructivist instructional practices and teacher efficacy in the science classroom. As Next Generation Science Standards are implemented, instructors must be able to make informed decisions regarding instructional practices.

Ascertaining the level of use for constructivist instructional practices among science instructors in the state of West Virginia, and teacher efficacy with regard to use of these practices is important if educators are to meet the needs of learners. This study contributed to the body of knowledge regarding effective instructional practice implementation and efficacy, providing information to assist West Virginia science educators with informed decision making. In addition it provides information to assist state and local policy makers as they implement programming and make funding decisions for professional development and supplies to ensure success of the Next Generation Science Standards.

This decision making includes providing direction for professional development at the state, regional, and local levels. At the state level the West Virginia Center for Professional Development holds a variety of workshops for educators to improve practice. West Virginia is also divided into eight Regional Education Service Agencies (RESAs) which hold professional development workshops as well as bring professional development to schools. County school boards and local agencies may also find the data useful in designing professional development to aid teachers as they implement the Next Generation Science Standards.

In addition the results of this study may aid instructors and policy makers in higher education as they strive to implement successful teacher preparation programs to meet the requirements of the Next Generation Science Standards. In order to give future science educators the skills they need to implement the new standards, higher education officials need to be able to make informed decisions regarding level of use of constructivist instructional practices and the role of teacher efficacy in practice selection.

Because teacher efficacy is shaped in the formative years of teaching, including student teaching, programming that promotes high levels of efficacy is paramount to teacher candidate success.

Finally, the results of this study added to the knowledge-base needed to continue providing challenging curricula for all students. Instructional practices utilized in science classes influence student mastery of curricula set forth in the Next Generation Science Standards. Expanding the knowledge base regarding level of use of instructional practices, teacher efficacy, and determining the relationship (if any) among these factors yielded information helpful to stakeholders as they construct methods of study designed to challenge and inspire today's students. Few studies have examined the relationship between teacher efficacy and instructional practice implementation in the science classroom. The results of this study helped define this relationship to provide information that can be used for future study.

Delimitations of the Study

This study was limited to West Virginia science teachers in public schools at the middle/junior high, and high school level (grades 6-12). West Virginia had 55 counties in 2011-2012 with approximately 125 high schools and 156 middle schools in the study period. According to the West Virginia Department of Education, there were approximately 1,898 science teachers for grades 6-12 in the 2011-2012 school year.

CHAPTER 2: LITERATURE REVIEW

The purpose of this chapter is to provide a review of the relevant literature. Section one provides a more in-depth review of the literature surrounding instructional practices in science education. Section two provides discussion regarding traditional and constructivist instructional practices. Section three is devoted to school factors serving as independent variables (class size, years of teaching experience, Advanced Placement instruction, and socioeconomic level). Finally, section four provides a deeper explanation of efficacy, science teacher efficacy, factors that determine efficacy, and the role of teacher efficacy in the selection of instructional practices.

Instructional Practices in Science Education

Instructional practices in science must be carefully chosen for several reasons (Bybee et al., 2006). Students may come to the science classroom with incorrect preconceived notions and require an adequate background of facts and context to build upon. Students must also have the ability to organize and retrieve knowledge. According to the authors science educators must teach content in-depth, recognize misconceptions, correct them, and teach reflective thinking. Instruction related to science involves more than teaching content for students to successfully grasp difficult scientific concepts.

Critical thinking in science education is also important, both historically and in today’s classroom (Vieira, Tenreiro-Vieira, & Martins, 2011). Educators must select instructional practices in the classroom that promote critical thinking. Critical thinking skills allow the general population to understand the scientific and technological advances occurring in today’s society, the importance of new discoveries, and to prepare individuals for careers in related areas. Students must be able to critically understand, assess, and make decisions based on the relevance of science to their lives.

Vieira, Tenreiro-Vieira, and Martins (2011) also suggested that students must be able to analyze evidence in arguments, present their own arguments, make inferences, and assess the credibility of sources. Students in today's society benefit from appropriate knowledge of variables, controls, accuracy, precision, context, validity, reliability, hypotheses, cause/effect, correlation, and significance. These concepts are part of both critical thinking and scientific literacy. The science classroom as an open, safe environment for creativity and questioning provides an opportunity to promote critical thinking, as well as the knowledge and attitudes to carry it successfully into the modern world. Activities in the science classroom including discussions, analyzing journal articles, reading scientific papers, and other relevant projects promote these skills.

Instructional strategies in the science classroom can be divided into two categories: macrostrategies and microstrategies (*Edvantia*, 2005). Macrostrategies include metacognitive activities (breaking down tasks and thinking about how they are organized) and active engagement with the physical world (hands-on constructivist practices), while microstrategies include independent practice (homework consisting of short regular practice activities), higher order thinking (to organize information and complete tasks), evaluation of evidence, and cooperative learning (with peers and adults). Students require appropriate feedback, context, differentiation, appropriate time, and scaffolding to successfully accomplish both macro and microstrategies.

Specific instructional practices in the sciences may also be needed to teach concepts related to the Nature of Science (NOS). In a study of preservice MAT teachers concepts including empirically based research, subjectivity, changeability, inferences, observations, creativity, subjectivity, change over time, and the role of society in science and vice versa were found to be well understood by participants (Abd-el-Khalick, Bell, & Lederman, 1998). However, participants were not as clear about the difference between a theory and a law, the importance of society and culture to scientific inquiries, and in video-taped lessons only three of the 14 participants explicitly taught NOS concepts though all expressed the importance of NOS. Instructors emphasized student needs, reasoning, social skills, process/tasks skills, content knowledge/application, and establishing a safe, secure, engaging learning environment over teaching NOS. Participants listed several reasons for not teaching NOS including more important topics, classroom management, lack of understanding/confidence, time constraints, and lack of resources/experience. Abd-el-Khalick, Bell, and Lederman (1998) suggested more support for preservice teachers to overcome these obstacles.

Appropriate professional development is also necessary for inservice teachers in difficult subjects such as science and math, especially when teachers are not fully certified and are teaching on permits (Huffman, Thomas, & Lawrenz, 2003). Various types of professional development including immersion, curriculum development, curriculum implementation, discussion of practices, and collaborative projects were analyzed in the study using a five point Likart survey for level of use of the selected practices. The level of use was compared to amount and type of instructor professional development. Curriculum development and discussion of practice had significant results.

Historically, selection of appropriate instructional practices have been an integral part of meeting the goals of new standards and objectives, including the four goals of the National Science Education Standards (NSES), a precursor to the Next Generation Science Standards (Yager, 2005). These goals included giving all students experience of the natural world, utilizing scientific principles for decision making, debating scientific/technological issues important to society, and becoming scientifically literate to increase productivity. The following instructional practices were proposed by the author to meet the goals: asking and answering questions, designing experiments, and collecting and communicating evidence.

Traditional Instructional Practices

Throughout much of the history of education, instruction has revolved around practices now termed "traditional" in nature. These instructional practices include lecture and teacher-led activities from a behaviorist theoretical framework (Paek et al., 2005; Woolfolk, 2010). Because many instructors teach in the manner they were taught, traditional practices are still very common in classrooms today (Borko & Putnam, 1996). Traditional learning practices, stemming from a behaviorist perspective, promote changes in behavior. Students develop a repertoire of appropriate responses to a variety of stimuli and educators reinforce those responses. For example, students memorize facts until they can repeat them automatically (Schuman, 1996; Standridge, 2002). Two general types of behaviorism include classical conditioning and operant conditioning, though both revolve around the idea that all behavior is learned and strive to examine how the learning occurs (Standridge, 2002). Both classical and operant conditioning focus on lower levels of

Bloom's taxonomy but foster appropriate teacher-pupil boundaries and are relatively easy to evaluate (Shirley, 2009).

Classical conditioning has a long history. Aristotle suggested that learning can occur by association, though the idea of classical conditioning was not fully developed until the 1920s when Ivan Pavlov trained a dog to salivate at the sound of a tuning fork when rewarded with food. Upon removing the food, the dog continued to salivate at the sound of the tone (Woolfolk, 2010). The author suggested these experiences can play a role in the classroom. For example students who have had negative experiences testing in the past may become nervous when assessed. These deliberate behaviors are also components of operant conditioning. John Watson proposed that human behavior originated when a stimulus produced a response (Standridge, 2002).

B.F. Skinner studied positive and negative reinforcements on behavior. Positive reinforcement consists of a desired stimulus presented after a behavior while negative reinforcement consists of removing an undesired stimulus when a behavior occurs (Woolfolk, 2010). For example, positive reinforcement includes obtaining rewards for achieving good grades, whereas negative reinforcement includes exemption from final exams for good attendance. Negative reinforcement is not the same as punishment (Good & Brophy, 1990). Punishment utilizes undesirable consequences that weaken and suppress behavior (Woolfolk, 2010). For example, a student receives detention when tardy for class, resulting in the student coming to class on time. Educators adopt these concepts and use them to reward desired behaviors and punish or modify undesirable ones (Standridge, 2002). The author listed the following as classroom applications of behaviorism: behavior modification, contracts, reinforcement, extinction, and consequences. Behavioristic methods may be useful for very young students, special needs students, covering large amounts of material, meeting deadlines, and classroom management due to the clear goals it provides (Shirley, 2009).

A third type of behaviorism, contiguity, is very context specific (Huitt & Hummel, 2006). In these situations the stimulus and response are connected in a specific time and/or place. The stimulus in this case is the environmental event and the response is the action or behavior. For example, a student playing sports associates the action of winning games with wearing a specific article of clothing during the time frame of the game. Other types of behaviorism are not context specific and focus on students learning facts and skills from an authority figure such as the teacher. Moussiaux and Norman (1997) explained that this type of learning is merely a transfer of factual knowledge so these methods can be of limited value if educators do not provide other supports.

Students also learn by modeling behavior (Standridge, 2002). They may not necessarily participate directly in the task but can repeat it later at another time as needed. For example, a student watches the instructor measure the temperature of water with a thermometer. Later in the year, the student may repeat the same procedure as part of another activity. Standridge linked modeling to the work of Bandura. Bandura (1986) stated, "Of the many cues that influence behavior, at any point in time, none is more common than the actions of others" (p.45). When modeling a behavior for others it is helpful to break it down into discrete steps, a process often referred to as shaping. The desired outcome is gradually guided or shaped until the student is successful. Cuing is used to guide the student both verbally and nonverbally throughout the process (Standridge, 2002).

In the behavioristic classroom students often receive information from an authority figure utilizing some form of lecture. There are several types of lectures. In a micro-lecture students are given portions of the lecture in chunks broken up by some other method such as discussion, summarization, or writing, before moving on to the next portion of lecture. Lecture sections may be as small as two to five minutes. In the write-share-insert method the lecture is broken down by a writing activity in which students make notes and share them with a partner. In the quick-review-and-out method the teacher or students quickly summarize the main ideas before moving on to another topic. In the mind-settling pause the teacher stops and gives students a moment of silent reflection before continuing. In lecture-with-feeling the teacher centers the lecture on real-life stories and events that grab attention instead of abstract concepts, people, or places (Harmin & Toth, 2006).

Constructivist Instructional Practices

Constructivist instructional practices are often student centered instead of teacher-centered, providing students with the opportunity to be active participants in their own learning (Paek et al., 2005; Woolfolk, 2010). Practices from a constructivist perspective promote student construction of knowledge with broad applications for problem solving under more ambiguous conditions (Schuman, 1996). Good and Brophy (1990) attributed constructivism to Bartlett while Woolfolk (2010) added Piaget, Vygotsky, Bruner, Rogoff, Watson, Dewey, and Lave to the list. There is no single constructivist theory of learning. But each variation agrees on two principles: learners actively construct knowledge and knowledge is constructed through social interactions (Woolfolk, 2010), compared to traditional practices in which the learner is passive.

Constructivism can be divided into two broad classes: psychological and social (Woolfolk, 2010). Psychological constructivists examine how meaning is formed for the individual, and are sometimes called individual constructivists. Constructivism revolves around how the individual constructs internal representations, modifies and stores the information, retrieves information, and analyzes and modifies information. According to the author, Piaget's version of this constructivism is sometimes called cognitive constructivism because the focus lies on the process of constructing meaning.

Social constructivism on the other hand was informed by the work of Vygotsky (Woolfolk, 2010). In this view students must participate in a variety of activities with others in order to appropriate new behaviors. Appropriation is "being able to reason, act, and participate using cultural tools" (Woolfolk, 2010, p. 312). The process occurs in the zone of proximal development, or the area where a child can accomplish a task with another's help. In this view cognition and culture create each other, making individuals a product of the society and culture to which they belong. Societal elements can be used to bring students to the zone of proximal development, as Moussiaux and Norman (1997) stressed the importance of activating prior knowledge. Not surprisingly this type of culture is more likely to emerge among students if it is already present among the staff (Becker & Riel, 1999). If staff members collaborate with peers, they are more likely to foster the same environment of collaboration among students.

In a climate where learning occurs in context, constructivists propose that assessment should occur in context as well. Testing should be integrated into the task and not a separate activity (Merrill, 1991). In doing all of these things students must be able to work together in a group or multiple groups to achieve the ultimate goal while taking ownership of the learning and understanding the influences that shape it (Woolfolk, 2010). Moreover information must be presented in many contexts throughout the year for students to successfully understand it in depth. This idea developed in the 1960s after the Russian launch of Sputnik via the work of Jerome Bruner. He created a spiral curriculum in which the work progresses from simple, concrete ideas to complex, abstract ideas throughout the school years (Hewitt, 2006). In doing so a variety of constructivist practices have been developed and used successfully in the classroom.

First, many constructivist practices utilize cooperative learning. Several types of cooperative learning are based on the way students are grouped. One of the most popular is the jigsaw method. In jigsaw, like other forms of cooperative learning, the teacher must explain the process to students and check for understanding before getting started. Students are assigned to heterogeneous groups or study teams and given the background material. The groups are then divided into expert groups and work together to master the subtopic assigned to that particular group. Then the expert groups return to the study team to teach one another their particular part of the topic, followed by assessment (Gunter, Estes, & Schwab, 2003).

Concept attainment can incorporate discussion into the classroom and is one model often used for vocabulary acquisition and other unfamiliar ideas. In concept attainment, the teacher prepares by selecting and defining a concept, selecting the attributes he/she wants the children to attain, and developing positive and negative examples. This preparation allows the teacher to determine when students have reached the goal. Then the process is introduced to the students. The teacher presents the examples and attributes and students work together to create a definition. They give additional examples and discuss the process as a class. Finally, students evaluate the work to ensure that it covers all of the information needed (Gunter, Estes, & Schwab, 2003).

Concept development allows students to build understanding of concepts and may incorporate discussion and group work. It is believed to mirror the natural human thought process. In this model students list as many items as possible related to the subject. Then they group the items by similarities. After establishing groups, the groups are labeled and reasons for the groupings are defined. When the groupings and their reasoning are clear to everyone, the items are regrouped or some groups are subsumed under others to consolidate groupings. The data are summarized and students make generalizations. Finally, student progress is assessed via item variety, grouping, and flexibility (Gunter, Estes, & Schwab, 2003).

In questioning, teachers ask questions of students, and students ask questions of each other to learn more about a topic. It is more interactive than listening to teachers explain answers in a lecture. However, the questions must focus student attention, stimulate thinking, and result in learning. Questioning can be used to hold attention, motivate students, and scaffold learning, so it is versatile and easily incorporated into other constructivist activities (Walsh & Sattes, 2005). According to the authors, quality questioning has four characteristics: a clear purpose, focus on content, facilitation of thinking at the appropriate cognitive level, and clear communication.

Several types of questioning also exist, including ReQuest and the Socratic Seminar (Fisher & Frey, 2007). In ReQuest (reciprocal questioning) students are taught to ask and answer questions of one another as they read. Initially the teacher may lead the process, but as students learn the process they can perform the tasks on their own. The text is read, and students take turns questioning and responding. It works best in pairs to ensure even participation. In the Socratic Seminar a text is selected and the teacher proposes a question to get the process started. The question should not have a right answer. The responses to the question should generate new questions from the students. The leader both facilitates and participates as necessary from that point. But the participants are responsible for the learning and must realize that they are not searching for a correct answer (Fisher & Frey, 2007).

Synectics is another method used to develop problem solving skills and creative thought processes. In this model students are given a topic. They are asked to describe the topic and create analogies using the topic. Next students create personal analogies for the object by assuming a view of reality from the object's perspective. After completing this step, which may be the most difficult, they go through the list and identify words that conflict with one another. Students use these words to create direct analogies, followed by re-examination of the original topic. Students finally evaluate their own thinking by identifying the processes which were helpful (Gunter, Estes, & Schwab, 2003).

Determining cause and effect relationships is an important part of critical thinking and problem solving. In the cause and effect model (which can be part of inquiry learning, problem-based learning, or project based learning) students choose the topic or problem they want to analyze. Then they look for the causes of the event and support for the causes. Next they look for the effects of the event and associated supporting evidence. Prior causes and subsequent effects are also analyzed (such as a chain of events). Finally, students form conclusions, generalizations, and evaluate their performance (Gunter, Estes, & Schwab, 2003).

Reciprocal teaching was developed in the 1980s by Palincsar and Brown for increasing text comprehension (Dell'Olio & Donk, 2007). Teachers and students alternate roles to summarize readings, predict what happens next, and clarify confusing passages or vocabulary. It is especially helpful for students who have good text decoding but poor comprehension. Teachers may have to provide a great deal of scaffolding at first to get students used to the model, but after they learn appropriate procedures the method can be used by students themselves. It has also been shown to be useful with parent/child reading activities, special education populations, those with learning disabilities, and English Language Learners (ELL). It is a constructivist method since it allows students to construct knowledge through interactions with others.

The vocabulary acquisition model is more interactive for students than hearing teachers lecture about the meaning of words. In this model the students are pretested to determine prior knowledge. Then discussions about spelling and possible meanings are used to elaborate. The data collected in the discussions are used to explore patterns of meaning. Students then read and study the concept in preparation for a posttest (Gunter, Estes, & Schwab, 2003).

The conflict resolution model can be used to determine solutions to either real-world problems or to predict possible solutions in a narrative or story. It can incorporate discussion and group work. First students list all of the important facts, participants, and actions related to the conflict. They identify the reasons for the actions and feelings of participants as well as reasons for the feelings. Next, alternative solutions are listed and examined for appropriateness. Similar situations are discussed for examples and assistance in determining feelings and reasons associated with solutions. The students choose a course of action and evaluate it, comparing it to alternative solutions and their consequences. Generalizations are made regarding the conflict and evaluated (Gunter, Estes, & Schwab, 2003).

Incorporating drama into the classroom, in activities such as role playing, are also beneficial constructivist activities, particularly for students from low SES backgrounds. Acting, role play, and other activities are child-centered, process oriented, active, and self-expressive. However, role play can also involve adults, as educators portray historical figures and demonstrate processes. However, the use of dramatic teaching methods is not without criticism. Many critics feel that dramatic methods are best reserved for the theatre classroom, as their focus is on group symbolism not the individual student (Pogrow, 2009).

In the values development model an overarching theme is identified and focus is directed to a singular question. Supplemental resources are provided and students explore interdisciplinary connections regarding the theme in order to create possible answers to the question. There should be no clear-cut right answer. During the process the instructor must model caring about the topic, anticipation, and learning techniques (Gunter, Estes, & Schwab, 2003).

Learning extends beyond the classroom and authentic experiences are as varied as writing to experts, planting a school garden, observing nature, visiting museums, bringing experts into the school as guests, and having a class pet (Daniels & Bizar, 1998). The commonality among each of these activities is that the experience is used for students to "build an understanding of themselves and their place in the world" (Daniels & Bizar, 1998, p. 173).

Problem-based learning (PBL) is a constructivist approach that allows students to learn both content and problem solving skills in an authentic setting. The problem being solved generally mimics one in the real world and may not have a correct answer. It is a type of project-oriented learning and can be related to inquiry based learning. It is a seven-step process (Schmidt & Moust, 1988, April). In the first step, the teacher explains the process and any new terms. Next, the problem is defined and analyzed through brainstorming and discussion. Learning issues are formulated so that students can study for themselves. Finally, students must share what they find.

Problem-based learning fosters higher-level thinking skills (Sevilla, 2012). It takes basic knowledge and comprehension and forces students to apply it to real-world problems. In order to do so they must analyze, evaluate, and synthesize the problem at hand. PBL utilizes all levels of Bloom's taxonomy. Moreover, it is applicable to all content areas, not just science. Sevilla explained that traditional teaching methods focus on the lower levels of Bloom's taxonomy, while PBL forces students to progress to higher levels.

Problem-based learning, inquiry based learning, and project based learning provide students with an authentic problem to solve. However, project based learning utilizes projects to accomplish student-centered instruction. Students are required to formulate and solve their own problems in this constructivist approach. Project based learning is different from traditional teaching methods since it focuses on the learner and the project to be produced and stems from the work of Dewey and Kilpatrick (Schneider, Stek, Krukowski, Synteta, Smith, & Schmitt, 2005)

Project-based learning can include experiments, field trips, and other hands-on, student directed activities. The teacher designs and facilitates these activities. Project based learning has the following characteristics: challenging but realistic problems, collaborative learning, student-set goals, a long-term nature, focus on content with a driving question, learning skills, interdisciplinary study, authentic experiences, and a productive outcome that has a clear benefit to the class and/or community. Students are responsible for time and resource management. Project based learning may involve other types of learning methods, either behaviorist or constructivist in nature, as needed for students to solve the problem (Schneider, et al., 2005).

Project-based learning and problem-based learning clearly have many similarities. But they differ in that project based learning focuses on production of a concrete item. Students focus on creating a product. In order to do so they identify an audience and design the item for that audience. They are responsible for managing tasks, dividing up the work, trouble shooting, reflecting, and evaluating the end-product. Student responsibility is key and again educators serve as facilitators and guides while students assume various roles. Assessment is frequent and carried out by teachers, peers, and the individual (Schneider, et al., 2005).

Like other constructivist methods, project-based learning has drawbacks. Project-based learning can be time consuming and expensive. Students may have difficulty forming appropriate research questions and designing a project. Projects can be very large so students may have trouble managing time and resources wisely. Like other cooperative methods, students may have difficulty collaborating. If students struggle, the teacher may have to help break the overarching problem down into sub-steps that are more manageable. If technology is involved learning to use it appropriately can also present challenges. Instructors may run into difficulties designing appropriate projects to cover content, following up on projects to tie learning together, and creating appropriate assessments (Schneider, et al., 2005).

Inquiry-based learning includes many types of constructivist activities and may encompass problem-based and project-based learning. Inquiry is the process by which scientists study and attempt to explain the world, and it includes the processes by which students develop understanding of the world around them as well. Students must come to master certain scientific ideas and understand how scientists reached these understandings and in doing so students mimic the role of the scientist (Dow, Duschl, Dyasi, Kuerbis, Lowry, McDermott, Rankin, & Zoback, 2000).

Increasing inquiry-based activities has been a goal in science education since the *National Science Education Standards* were proposed over a decade ago. The inquiry process involves students asking questions using the knowledge they already have to acquire more knowledge to solve the problem. For inquiry to be successful students should add to their knowledge base and realize that this new knowledge can be built upon by asking new questions and solving new problems. Inquiry-based learning is a cycle that builds upon itself by questioning and refinement (Dow, et al., 2000).

Teachers must provide students with direct experiences for inquiry-based learning to be successful. Students must practice the process of scientific inquiry, asking questions and researching on their own to answer the questions. This inquiry can involve research in books and journals, experimental investigation, and analysis of results. Inquiry requires critical thinking, logic, and consideration of many possible explanations and alternatives. Experience leads to understanding. Educators must facilitate understanding of the inquiry process and help students reflect on the processes and their own learning if they are to be able to replicate it without assistance under new circumstances. Inquiry learning is constructivist in nature due to this student centered emphasis. Students' own ideas and experiences can be drawn from to create inquiry experiences. Once students see that the scientific process can help them solve problems, they will have a deeper understanding of the scientific process as well as the tools necessary to carry out future studies (Dow, et al., 2000).

In this study, teachers were surveyed using selected research-based constructivist instructional practices on a five point Likart type scale for level of use with one being "Never Used" and five being "Very Frequently Used." Teachers were presented with a list of strategies and selected the level of use that best described their classroom. Several school factors also served as independent variables and will be discussed next. Class size, teaching AP or pre-AP courses, years of teaching experience, and socioeconomic status were examined as part of this study.

School Factors and the Use of Constructivist Strategies/Efficacy

Class Size

Multiple stakeholders believe class size reduction is beneficial to students, as well teachers, principals, and parents (Picus, 2000). Consequently, nationwide class size has fallen from a 27:1 student-teacher ratio in 1955 to 17:1 in 1997, counting Title I and special education teachers. The author explained that more educational dollars are spent to reduce classroom size than increase teacher salaries. However, according to the author educators in smaller classes reported higher morale and the opportunity to implement new instructional practices.

Indiana's Prime Time Project and Tennessee's Project STAR are two initiatives that limited class size while tracking student progress (Achi, 2011). Students in both studies showed benefits from the smaller classes. The STAR program in particular yielded rich data due to random assignment of students to reduced-size classrooms, regular classrooms, and regular classrooms with an aid. Teachers were randomly assigned to the classrooms. In each year of the study the students in reduced-size classrooms exceeded their regular classroom peers in achievement. In addition, students in small classes were two percent more likely to be enrolled in college years later (Whitehurst & Chingos, 2011).

Wisconsin's project SAGE reported similar results with students in urban areas (Achi, 2011). Class size was reduced in kindergarten the first year of the study followed by successive reduction in the next grade level classrooms the following years. Benefits were particularly visible for poor, minority, at-risk, and special needs students. However, for significant impact to occur, students needed to start the program in kindergarten, and remain in small classes for at least three and preferably four years. Such initiatives resulted in lower retention, higher graduation rates, and more students graduating with honors (Achi, 2011).

Critics of class size reduction argue that the gains are not significant enough to merit the expenditures associated with smaller classes and that pupil-teacher ratio is not an accurate measure of class size since many schools include teachers such as music, art, physical education, and aids who do not have their own classroom in the count (Achi, 2011). Other critics claim that the educational benefits do not justify the financial burden in tough economic times. Increasing the student-teacher ratio by 1 student across the nation would save $12 billion dollars a year (Whitehurst & Chingos, 2011). The authors also suggested that, if the least effective teachers were laid off to accomplish this reduction, the effect on student achievement would be negligible. The authors warned that educators must carefully weigh the financial benefits of maintaining smaller classes vs. cutting other programs such as art, music, and athletics in order to maintain smaller courses. In addition, school systems must consider the cost of construction of new classrooms to house additional course sections (Picus, 2000).

Flower (2010) found that even though the results of studies on class size reduction are mixed, experts agreed on three points: low SES students benefit from smaller classes, low ability level students benefit from smaller classes, and smaller classes positively impact student attitude. However, the author cautioned that reducing class size without changing instructional practices and supporting teachers with training, resources, and professional development is not enough to help students. The results of research on class size reduction are clearly mixed. It is therefore important to ascertain the influence of class size on level of use of instructional strategies and teacher efficacy. Research on total years of teaching experience vs. achievement has also shown mixed results and will be analyzed next.

Years of Teaching Experience

Total years of teaching experience, like class size, is a variable often examined in studies related to student achievement, particularly when educators are seeking to raise achievement for a particular group of students or close an achievement gap. This factor is a particularly important area of research since many states tie teacher pay to the number of years of classroom experience. Teacher experience has been shown to positively influence student achievement, but only during the initial years of teaching (first three-five years) (Holley, 2008). The first three-five years in the classroom seem to be the most critical. Other studies found that teaching experience does matter and that educators continue to improve practices well beyond the three-five year mark (Haimson, 2011). She suggested that educators continue to improve practice for 15-20 years. Such findings have serious implications for school systems seeking to improve student achievement by laying off experienced teachers.

Teacher performance in the classroom improved each year for the first four years and then leveled off on the fifth according to McCue (2011). However, the author also found that teacher practices may be more important to achievement than years of experience so continuing teacher education through quality professional development could help improve student achievement after five years. The author also suggested that teacher beliefs play a role in student achievement, which was examined in this study using teacher efficacy.

Controlling for other factors the two teacher characteristics most closely tied to student achievement were years of experience and teacher test scores in a study by Clotfelter, Ladd, and Vigdor (2007). The authors used a value added model and years of experience as linear indicator variables with the expectation that the greatest gains would be made in the early years of teaching, as many other studies have indicated. The authors did find that teachers with more experience were more effective than beginners. These effects were more pronounced during the initial years of teaching, but continued to rise slightly throughout the years studied.

Teacher factors including experience were examined over a three state area yielding inconsistent results in the relationship between teacher experience and student achievement (Jones, Alexander, Rudo, Pan, & Vaden-Kiernan, 2006). Teacher experience was positively associated with student achievement in only fourth grade math for one state. However, in each state that participated in the study, teacher experience was the largest determining factor for salary. Interestingly, teachers with lower pay, and therefore less experience, were found to be located in the poorest schools participating in the study. In another study teacher experience was found to be a significant factor in reading scores (reading vocabulary and reading comprehension) but only when comparing beginners to educators with ten or more years in the classroom (Rockoff, 2004). In addition, school factors such as years of experience may be impacted by student socioeconomic status (SES) (Jones et al., 2006).

Teacher quality is clearly hard to measure and may be driven by something less tangible than years of experience (Rockoff, 2004). Some studies did not find that increased teaching experience resulted in significant gains in student learning (Giglio, 2010). The author found that increasing teacher experience five years resulted in less than one percent positive increase in student achievement. The author suggested that new ways of measuring teacher effectiveness and compensating teachers may be necessary.

Criticism regarding the impact of teacher experience on student achievement has been documented since the 1966 *Coleman Report* (Hanushek & Rivken, 2007). Since that time, multiple studies have been published on both sides of the teacher experience debate. The authors were particularly concerned with the tendency of more experienced teachers to gravitate toward better schools and more academically oriented students (Coleman, Campbell, Hobson, McPartland, Mood, & Weinfield, 1966). If teachers with more experience tend to go to higher achieving schools, teacher experience may not be a determining factor in achievement. It may be an indicator of easier-to-educate students. Working conditions play a major role in teacher satisfaction, and higher compensation may be necessary to get more experienced educators into poor or dangerous schools. Consequently, this study examined the effects of SES on level of use of constructivist instructional practices and teacher efficacy.

Socioeconomic Factors

Students from low socioeconomic backgrounds suffer many disadvantages in school compared to higher socioeconomic students (Banks & Banks, 2007). In this study SES was measured by a self-reported survey question in which teachers indicated the percentage of students eligible for free-and-reduced lunch using categories from the *Improving Teacher Quality Grant Program Participant Survey* administered by Marshall University in 2011. The respondents selected the category that best described their school from the following list: less than 35%, 36-50%, 51-75%, and 76% or more.

In Ruby Payne's *A Framework for Understanding Poverty* (2005) two types of poverty are examined. First, in generational poverty, the family has been in poverty for at least two generations or lives with others who are already part of generational poverty. A key characteristic of generational poverty is a sense that society bears responsibility for providing for the family. On the other hand, situational poverty is a lack of resources due to a specific situation that has occurred and may be mitigated, such as a death in the family, illness, or divorce and the family may not be willing to accept assistance to maintain pride.

Generational poverty is more debilitating. The following are characteristics of generational poverty: survival orientation, matriarchal structure, casual oral-language, men viewed as lover or fighter, women viewed as caregiver/martyr/rescuer, presence of background noise (like the TV on at all times), emphasis on personality/humor, emphasis on entertainment, focus on relationships, non-verbal and kinesthetic communication, negative remarks for any type of failure, punishment/harsh discipline, disorganization, belief in fate not choice, ownership of people, emphasis on the present time/in the moment, and polarized thinking (Payne, 2005).

Other categories of poverty include absolute, relative, urban, and rural (Jensen, 2009). In absolute poverty, which is rare in the U.S., families lack shelter, water, and food. Relative poverty occurs when a family's income is lower than society's average living standard. Urban poverty occurs in areas of at least 50,000 people with over-crowding, violence, noise, pollution, and dependence on city services. Finally, rural poverty occurs in areas with populations below 50,000 where there are fewer services, and more single parent homes. Less opportunity for education, help with disabilities, and opportunities to obtain jobs are available in these areas. Rural poverty levels are increasing and exceeding those of urban areas (Jensen, 2009).

Low SES students facing these challenges place a burden on the school system that it is not equipped to meet (Holliday, 2011). Consequently many of these children fail when the system does not adapt. From lack of support services to shortages of basic tools for success (paper, pencils, etc…) low SES students may not have the items they need to work in school (Payne, 2005). The effects of low SES on student outcomes have been known for many years. Many low SES students lack enriching educational experiences when they start school, including books, computer, and travel to enriching locations (museums, zoos, parks, etc…).

The disadvantages faced by low SES students can compound the problem of low test scores when compared with other nations, according to Bracey (2009). The U.S. regularly scores unfavorably in areas such as math and science when compared with other developed nations on assessments such as the NAEP and PISA (Schleicher, 2011). However, the U.S. has a high percentage of children living in poverty who lack the quality educational experiences necessary to prepare them for standardized testing. Bracey (2009) found that high SES students from wealthier schools outscored nearly all other developed nations in math and science. Only when low SES students were averaged into the equation did U.S. scores fall below that of other nations. Payne (2005) reported that one reason schools face so many challenges today is the decreasing number of middle class students and increasing number of students of poverty.

Students facing these challenges do not come to school with the appropriate cognitive strategies for learning and may act out in a variety of ways, ultimately ending up labeled and placed in special programming (Payne, 2005). The author warned that not all of these students should be placed in special education; the population is becoming too large. Instead students must be given the strategies they need despite the challenge it presents to educators. This challenge is partly due to differences between the hidden rules of education (middle and upper class norms utilized in the classroom) and the hidden rules of the culture of poverty. For example, according to the author relationships and entertainment rate highly among the priorities of low SES families, so fostering relationships between parents and the school may be one way to overcome these challenges.

Teachers must build quality relationships with students and plan lessons that grab students' attention. After gaining students' attention, educators must support them throughout the learning process. Teachers must plan carefully for students and anticipate areas of difficulty by carefully monitoring students to catch problems early before they result in failure, low self-esteem, and learned helplessness (Jackson, 2009). Teachers must be proactive not reactive. Proactive support "is rooted in the belief that all of our students can achieve at high levels given the right conditions" (Jackson, 2009, p. 105), once again implicating the importance of educator belief (efficacy) in the educational process.

Failure to provide an appropriate education for all children may result in the U.S. falling behind in today's information and technologically driven society (Holliday, 2001). Students who do not do well in school or dropout were traditionally incorporated into the low skill labor market relatively easily. However, these jobs are quickly being lost to overseas markets in the global economy (Ingrum, n.d.). According to the author, the job outlook for high school dropouts in the current economy is bleak, and educators must stress the importance of staying in school. Completion of high school is one way low SES students can escape and stay out of generational poverty (Payne, 2005). The author reminded educators that poverty is not about intelligence or ability (or lack thereof); many individuals in low SES situations do not know that they have other choices, or have no one to teach them the hidden rules of the middle class. Social difficulties arise when students do not understand the rules and norms of the middle class. Schools may be the only place students have the opportunity to learn these rules.

Physical and emotional support, language stimulation, and time for positive interactions may all suffer as a result of poverty. As the child develops and enters school, the parents' past negative experiences in the educational system can result in unwillingness to assist the child with participation in school and extracurricular activities (Jensen, 2009). According to the author this unwillingness/inability to assist the child may be due to parental depression, low self-esteem, inability to cope, and feelings of powerlessness. Breaux (2007) suggested that educators reach out to parents in a positive way. Educators should contact parents when students are doing something well, not just call home when students get in trouble. Educators cannot use low socioeconomic status as an excuse to exclude parents from the educational equation (Holliday, 2011).

The effects of low SES have been studied for several decades particularly with regard to low academic performance and dropout rates. In 2011 West Virginia had a 15.5% high school dropout rate, and 11,000 teens age 16-19 were not attending school and were not working (Anne E. Casey Foundation, 2012). In the early 1960s the most important factors related to dropout rate were found to be low SES, parents with low educational levels, parents who do not value education, low GPA, and incompatibility with the school social system (Bertrand, 1962). Many of the factors listed in addition to low SES have been found to be closely tied to poverty anyway, compounding the problem for low SES students and increasing their likelihood of low academic performance and dropping out of school. The situation is compounded even further when low SES students have a learning disability, making them even more likely to drop out of school than peers with only one disadvantage (Ingrum, n.d.).

Students of poverty experience these difficulties due to a variety of factors in their lives (Jensen, 2009). Both genetics and environmental influences play a role in the child's development and ability to interact with the environment throughout life. The author cautioned that educators must remember that the nine months the child spent in the womb were critical times for development, especially brain development. Low SES mothers are more likely to lack prenatal care, be exposed to toxins, and have high levels of stress which can harm the baby's development.

In addition high mobility after birth negatively impacts students and the ability of teachers to reach them (DuFour, DuFour, Eaker, & Karhanek, 2010). Students may not try to make friends at new schools, since they know they will be moving again and only have to leave them behind. They may not try to succeed at school for the same reason and they may not be placed in the best classroom to meet their needs due to lag time between schools transferring student records. Often schools do not have a standard policy for dealing with highly mobile low SES students. "Educators readily acknowledge that the fate of a student who is not learning will depend on the randomness of the teacher to whom he or she is assigned rather than any collective, coherent, systematic plan for meeting the needs of all students" (DuFour, DuFour, Eaker, & Karhanek, 2010, p. 39). It is therefore critical for staff members to sit down together and devise a school-wide plan to assist these students in achieving success.

Several factors, including low SES are strongly correlated with test scores in school (Levitt & Dubner, 2009). The parents' education level, age of mother (30 or older) at the time of her first child's birth, speaking English in the home, parental involvement in PTA, and many books in the home are all positively associated with test scores. Unfortunately, low SES homes may lack one or more of these characteristics. However, there are some steps educators can take to help low SES students succeed (Bruce, 2008): reduce class size, especially in early elementary grades, maintain a positive attitude and belief that all students can learn, relate new knowledge to students' experiences, and use flexible instructional strategies. These instructional strategies include the use of constructivist based practices that engage the learner and provide the opportunity for skill development in multiple areas.

Building low SES students' core skills in such a way that they can be transferred to all subject areas is also an important way of overcoming some of the challenges faced by students of poverty (Jensen, 2009). According to the author these skills include attention and focus, short and long-term memory, sequencing/processing, problem solving, application of skills in the long term, social skills, and hopefulness/self-esteem. This emphasis on social skills and self-esteem is not a new suggestion. As students from a variety of backgrounds predisposing them to learning difficulties entered school in the past few decades "socialization was deemed by many to be a more important function of the schools than intellectual development" (Henson, 2006, p. 49).

The challenges in teaching these students may seem insurmountable, so it is critical for educators to avoid blaming the students. Educators have a responsibility to teach low SES students the appropriate behaviors they need for success in schools (Jensen, 2009). Children do not get to choose their parents or home environment. They have no control over the behavior of their parents, either before or after birth. It is not the students' fault parents may be unemployed, underemployed, addicted, or absent.

Though the situation may seem hopeless, there is a very real prospect of changing low SES students' outcomes (Jensen, 2009). The author encouraged educators to not give up on low SES students since the human brain is designed to change. Appropriate stimulation and learning, exercise, and proper nutrition can go a long way in mitigating the effects of poverty. In this study school SES was examined as a factor in the science classroom due to the increasingly large number of SES students entering the school system and the fact that proper stimulation can help them achieve success. Science educators have a responsibility to reach all student populations with the Next Generation Science Standards and provide a rigorous yet supportive learning environment.

The College Board promotes raising student expectations as a way of helping overcome poverty (Newman, 2002). If students expect to succeed, they will. If they expect to fail, they will accomplish this goal as well through what the author called a self-fulfilling prophecy. However, educators can work to raise student expectations. Newman (2002) found, "Among students who expect to complete a bachelor's degree program, low-income students are almost as likely as high-income students to enroll in college" (p. 272). The College Board oversees the Advanced Placement (AP) program, and cited low SES student participation in AP as one method to help advance the educational opportunities of students of poverty. Therefore, teaching an AP course in high school or a pre-AP course in middle school was analyzed as another independent variable in this study.

Advanced Placement Programming

At the end of World War II educators realized a gap was developing between secondary education and higher education. A more highly educated workforce was necessary in an industrial society. The Ford Foundation created the Fund for the Advancement of Education in 1951, which supported studies dedicated to increasing the education of the population. The studies supported by the program indicated that secondary and higher education should work together to ensure that students do not have to repeat coursework (*A Brief History of the Advanced Placement Program*, 2003; Schneider, 2009)

In a study conducted by Andover, Exeter, Lawrenceville, Harvard, Yale, and Princeton, recommendations were made to institute achievement exams to help students enter college with advanced standing, and to challenge upper-level high school students with independent study and college-level work (*A Brief History of the Advanced*

Placement Program, 2003). The report was headed by Alan R. Blackmer and John Kemper (*History of the AP Program*, 2011; Schneider, 2009). Titled *General Education in School and College* and published through Harvard University Press, it implored high schools, colleges, and universities to work together for the good of students (*History of the AP Program*, 2011).

In a second study completed by the *Committee on Admission with Advanced Standing*, recommendations were made to institute advanced curricula in high schools. In order to accomplish this goal, the committee collected representatives from various higher education disciplines to develop course descriptions and assessments for high school students to use to earn college credit (*A Brief History of the Advanced Placement Program*, 2003). This report, headed by Kenyon College president Gordon Keith Chalmers, involved 12 schools and 12 colleges. It resulted in a pilot program with seven schools (*History of the AP Program*, 2011). In 1952 eleven subject areas were piloted in these schools by the Educational Testing Service (ETS) but by 1955 The College Board was asked to begin administering the program on a larger scale (*A Brief History of the Advanced Placement Program*, 2003). This pilot coincided with the proliferation of large high schools in the 1950s, as James Conant and others saw larger schools as a way to offer more courses, uniformly, and efficiently (Kaestle, 1983). The program was named the College Board Advanced Placement Program (*A Brief History of the Advanced Placement Program*, 2003) and was placed under the direction of Charles R. Keller of Williams College (*History of the AP Program*, 2011).

These programs were fueled by several historical and political developments. In 1957 the launch of Sputnik by the Soviet Union fueled a focus on content in the curriculum, particularly math and science. The Cold War brought the need for a quality education to ensure American scientific and technological dominance (Hewitt, 2006; Schneider, 2009). The National Defense Education Act of 1958 was a manifestation of the rising fear for national security if education were not improved (Schneider, 2009), and the AP program continued to expand. This expansion occurred despite the publication of *The Coleman Report* which indicated that teachers' practices may not have the significant effect on student outcomes previously thought (Coleman et al., 1966). As the 1960s progressed policy makers became concerned about rising poverty levels. Much educational expansion occurred in the 1960s due to the fact that "schooling had become one of the prime weapons in the war on poverty and a central concern not only of policy makers but also of the dispossessed…." (Tyack, 1974, p. 270).

As the 1960s gave way to the 1970s and 1980s more and more schools began adding AP courses to the curriculum. In the 1980s and 1990s active efforts to recruit minority and low SES students into AP programs began (*A Brief History of the Advanced Placement Program*, 2003). After the publication of the *A Nation at Risk* report in 1983 schools were especially focused on creating challenging curricula for all students (National Commission on Excellence in Education, 1983). In 1989 the nation's governors met in the Charlottesville Educational Summit and wrote six national education goals, later named the *Goals 2000: Educate America Act* (1994), which included rigorous academic standards.

These changes may have been due in part to legislative actions on the state and national level. However, during the 1970s some social scientists began questioning the reform acts, stating that Americans were becoming more educated than necessary for the jobs that would be available and that education may not be an escape from poverty. These complaints were not a coincidence as nontraditional students began furthering their education. The authors wrote "In abstract, people may favor giving all children a fair chance, but at the same time they want their children to succeed in the competition for economic and social advantage" (Tyack & Cuban, 1995, p. 29).

The 1990s also saw several important pieces of legislation that influenced policy related to AP instruction. In 1996 the National Commission on Teaching and America's Future published the report *What Matters Most: Teaching for America's Future,* which helped pave the way for more professional teaching standards. In 1998 President Clinton reauthorized the *Higher Education Act* (Earley, 2001). In 2002 President Bush reauthorized the *Elementary and Secondary Education Act* also known as *No Child Left Behind (NCLB)*, which focused on equal opportunities for all students to receive a quality education (US Department of Education, 2002). As a result, pre-AP and AP Vertical teaming programs were placed in schools around the country to further increase enrollment and college preparation.

Many of the same upper-level preparatory schools that originally helped initiate the AP program are moving away from it due to criticism of standardized tests (Schneider, 2009). AP courses culminate in a standardized exam, and in the wake of increased standardized testing, increased student workload, and accompanying stress, many schools are beginning to take a different approach to assessment. According to the author other schools fear AP emphasizes breadth over depth and that its influence in higher education is waning as more students from less elite backgrounds are taking advantage of the program. However, Schneider explained that creating an atmosphere of privilege was not the intent of the program. The program was intended to challenge and track the best and brightest students, but not give them special privileges or an edge in college admissions. Many schools allow any student who wants to take an AP course to enter the classroom, regardless of preparation level. These open-door policies further lower the status of AP courses in the eyes of critics and some universities, that no longer grant AP credit. Elite schools dropping the AP program could undermine its usefulness in struggling schools striving to increase rigor in their curriculum as colleges and universities begin to see it as outdated (Schneider, 2009)

AP was however inevitably pulled into the battle against school inequalities in the 1960s (Schneider, 2009). Traditionally, AP was reserved for white, upper- and upper-middle class students in private or suburban schools. Educators arguing for reform felt the program should be offered to those students long denied a quality education and the opportunity to enter college or university. Schools soon became a testing ground for President Johnson's *Great Society* program, and AP was part of the battle. According to the author AP expanded across the nation in the following decades, with some states including West Virginia legislating requirements for schools to offer a minimum number of AP courses. AP is currently becoming available online to further reach isolated and underserved student populations.

The history of the AP program, as well as the historical and political influences that shaped it, are important for educators to understand as they examine instructional practices in the classroom, particularly the science classroom. In this study survey respondents were asked to indicate if they taught an AP course in the past five years, including the 2011-2012 school year. This independent variable was analyzed in relation both to level of use of constructivist instructional practices and level of teacher efficacy. This analysis was important due to the specific training AP teachers receive through The College Board, which may influence level of implementation of instructional practices and belief that an instructor is making a difference in the classroom.

Teacher Efficacy

Teacher efficacy is defined as "teachers' confidence in their ability to promote students' learning" (Woolfolk Hoy, 2000, p. 2). The roots of efficacy research began in the 1960s with Rotter's work on locus of control theory (Henson, 2001). Efficacy first emerged as an area of study over 30 years ago when the Rand Corporation asked teachers to indicate level of agreement or disagreement with the two statements below as part of a study of reading instruction (Goddard, Hoy, & Hoy, 2000; Protheroe, 2008).

1. When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment.
2. If I try really hard, I can get through to even the most difficult or unmotivated students (Armor, Conroy-Oseguara, Cox, King, McDonnell, Pascal, Pauly, & Zellman, 1976).

Teacher confidence influences the selection of instructional practices. Time, effort, and resources will be devoted to those practices the teacher believes will be the most successful. Efficacy is therefore related to nearly every facet of classroom life from classroom management to time allocation and special education referrals (Woolfolk Hoy, 2000). Moreover, according to the author, efficacy is developed early in the teaching experience during student teaching and the first years in the classroom.

Albert Bandura (1997, 1977) was one of the first to closely examine teacher efficacy based on his social cognitive theory. He examined human agency, or one's control of one's life. He later extended this to collective agency, or the ability of a group to work together to reach a goal. He found four sources of efficacy: mastery experiences, the emotional and physiological state, vicarious experiences, and social persuasion. Moreover, efficacy is specific to context, so each of these sources may be different dependent upon the context the educator finds him/herself presented with at the time. Of the four efficacy sources, mastery experiences are the most powerful (Henson, 2001). If a teacher believes his/her efforts to be successful, efficacy is increased and vice versa. If the success is attributed to factors within the instructor's control, as opposed to luck, efficacy is further enhanced (Woolfolk Hoy, 2000).

Social persuasion and vicarious experiences depend upon the instructor's interactions with others. In a vicarious experience someone the individual identifies with models the behavior. If the activity is successful and the identification is close, efficacy is enhanced (Woolfolk Hoy, 2000). For example, if one teacher observes another using a particularly effective method, she/he will be more likely to use it themselves (Protheroe, 2008). In social persuasion another individual or individuals provide feedback. This feedback can come from the principal/supervisor, fellow educators, or outside sources (Woolfolk Hoy, 2000). The principal can help teachers develop positive efficacy and improve the efficacy of the entire school (collective efficacy) (Protheroe, 2008). The initial feedback may produce only a short-lived change in individual efficacy, but, if positive, it may be enough to encourage an educator to try new instructional practices (Woolfolk Hoy, 2000).

The organizational structure of schools can also affect teacher efficacy. All organizations have norms, and schools are no exception. Teachers quickly pick up on subtle and not-so-subtle cues regarding these norms (Woolfolk Hoy, 2000). The school culture itself can influence the efficacy of both staff and students (Protheroe, 2008). Socialization regarding school norms actually begins during the student years as future teachers observe professionals in the field who serve as positive and negative role models. New norms and values are presented when the individual enters college, during student teaching, and finally upon entering their own classroom (Woolfolk Hoy, 2000). This process is part of Bandura's triadic reciprocal causation in which environmental influences, behavior, and personal factors intertwine to produce educator agency (Henson, 2001) and leads to the two classes of efficacy (collective and teacher).

First, the school's collective efficacy can have a major impact on student achievement. Schools with high collective efficacy exhibit a "can-do" (Protheroe, 2008, p. 44) attitude. These schools are better able to cope with challenges and do not give up when things become difficult. Schools with a low collective efficacy do not cope as well with difficult situations, and staff members are more likely to utilize student factors like poverty to explain low performance, rather than accepting the responsibility themselves. A positive relationship exists between collective efficacy and achievement.

Goddard, Hoy, and Hoy (2000) created a model of collective efficacy based on Bandura's (1977; 1997) four sources of efficacy, task analysis, and teaching competence. The authors classified collective efficacy as an emergent attribute in which the sum of the whole is greater than the individual parts. Because high teacher efficacy is positively related to student achievement, increasing collective teacher efficacy can lead to improvements in achievement. But the authors suggested that the relationship is not one-way; it is a cyclical relationship in which high efficacy leads to improvements in achievement, which leads to higher efficacy and the cycle continues. Moreover, once established positively or negatively, collective efficacy is, according to the authors, difficult to change (Bandura, 2000; Goddard, Hoy, and Hoy, 2000)

Goddard, Hoy, and Hoy (2000) applied collective efficacy to Bandura's (1977; 1997) four sources of efficacy. For mastery experiences the authors' suggested that teachers experience success/failures as a group. Success enhances efficacy and failure undermines efficacy. Schools with high efficacy can cope with stress better than those with low efficacy, coming out of periods of disruption or struggle strong. Low efficacy schools come out of periods of struggle with dysfunction, indicating a direct relationship between efficacy and physiological state. Faculty in high efficacy schools benefit from the vicarious experiences of others, listening to the successes and failures of those with similar student populations and learning from them. Educators in high efficacy schools enhance one another's efficacy through positive reinforcement, professional development, and positive administrative feedback. Goddard, Hoy, and Hoy (2000) added two more factors in addition to these four provided by Bandura (1977; 1997). In analysis of the teaching task, educators in high efficacy schools constantly assess what is going on in the classroom and make adjustments at the individual and organizational level in factors such as student motivation/ability, resources, and infrastructure. Finally, in assessment of teaching competence teachers assess one another based on factors for school success (teaching skills, training, methods, expertise, and student ability).

Goddard, Hoy, and Hoy (2000) used the efficacy survey to examine these factors and found that teacher efficacy was a strong predictor of student achievement. In fact, an increase of one collective efficacy unit for a school resulted in an 8.62 increase in math achievement and an 8.49 increase in reading achievement. The authors attributed this gain to educators in high efficacy schools acting purposefully for the benefit of students. Collective efficacy would be an appropriate avenue for future study. However it is beyond the scope of this study. Collective efficacy is an extension of individual teacher efficacy (Tschannen-Moran, Hoy, & Hoy, 1998), which was the focus of the current study.

Teacher efficacy can play a major role in classroom management practices, which can in turn effect instructional practice selection and implementation. Generally a lower sense of efficacy results in a more controlled classroom environment (stricter rules, punishments, etc…) (Woolfolk & Hoy, 1990). This type of atmosphere and the desire to maintain control do not lend themselves to the implementation of new practices, particularly those from a constructivist theoretical framework. Plus, level of efficacy can be resistant to change once firmly established (Woolfolk Hoy, 2000), though it tends to fluctuate during the college/student teaching years as young instructors lose enthusiasm in the face of the challenges and stress of the classroom (Woolfolk & Hoy, 1990).

Goddard, Hoy, and Hoy (2000) pointed out that efficacy is difficult to measure because it is also context specific. Contexts that can impact teacher efficacy include subject, students, and class period. Context is dependent upon the factors that make teaching a particular group difficult. Each class and group of students is different, and the instructor must realistically assess his/her strengths and weaknesses in reaching each unique group of students. Instructors must also assess the usefulness of available resources. These factors interact to impact efficacy. Therefore a teacher's efficacy level may vary with every class taught.

Woolfolk Hoy (2000) found that teacher efficacy generally increased during college coursework, but fell once the teacher entered the classroom fulltime. The author also found that greater efficacy resulted in fewer sick days for the fulltime instructor, which was related to perceived difficulty of the teaching position, perceived success in the position, and personal satisfaction with performance. Teachers who received more support during the first year of teaching had higher efficacy and may be more open to new ideas and methods and exhibit greater resiliency when presented with challenges in the future.

Teaching efficacy is often broken down in several ways. First it may be divided into two categories for study, General Teaching Efficacy (GTE) and Personal Teaching Efficacy (PTE) (Woolfolk & Hoy, 1990). PTE is related to the instructor's personal confidence and ability and may be independent of GTE (Protheroe, 2008). Factors including amount of effort, persistence and resilience in the face of challenges, and stress that can be influenced by PTE (Goddard, Hoy, & Hoy, 2000). GTE refers to the instructor's belief about reaching students in general, especially those students who present challenges (Protheroe, 2008). In addition Bandura (1997) broke efficacy down further into seven dimensions: resource efficacy, instructional efficacy, disciplinary efficacy, parental efficacy, community efficacy, decision-making efficacy, and positive school climate efficacy. However, Woolfolk Hoy (2000) was not able to break efficacy down into these seven constructs for analysis in her study of pre-service to fulltime teacher efficacy changes, possibly due to sample size.

Due to the complex nature of teacher efficacy, particularly quantifying GTE and PTE, there are several criticisms of teacher efficacy studies. One of the primary criticisms is whether or not the theoretical framework is that of teacher efficacy itself or part of the original locus of control theory (Henson, 2001). Henson proposed that Tschannen-Moran, Hoy, and Hoy (1998) wove together the two constructs utilizing Bandura's four sources of efficacy as well as task analysis and teaching competence to try to make sense of the overall construct. Task analysis focuses on the elements of the teaching situation and is closely related to GTE, whereas teaching competency focuses on the individual and his or her current abilities, more closely resembling PTE (Henson, 2001).

Other critics argued that teacher efficacy is so content specific that the efficacy scales used to measure the construct are not specific enough to each individual context. These measures of efficacy are referred to as global, requiring teachers to base judgment for their rating on aggregated situations from the classroom that may or may not actually pertain to what the questioner had in mind (Henson, 2001). The judgments are based on context, but if context specificity is not provided, difficulties with discriminant validity arise. However, if context becomes too specific, generalizability will be sacrificed, presenting educational researchers with a dilemma either way according to the author.

A lack of experimental and quasi-experimental research regarding efficacy exists (Henson, 2001). The author explained that most efficacy studies are self-reported, survey, or correlational. This study was no exception. Due to the deficit of experimental research, Henson (2001) described the results of most efficacy studies as a cross-sectional snap-shot of instructor perceptions. A deficit of research exists for teacher and collective efficacy in areas of efficacy development, relationships between sources of efficacy, and long-term change through longitudinal studies according to the author.

However discoveries in efficacy research have yielded significant enough results to merit further study including experimental interventions, quasi-experimental studies, and direct observation (Henson, 2001). Research has indicated that such interventions would carry more weight during the initial years of teaching, since efficacy stabilizes as teachers gain experience. However the author reminds policy makers and professional development leaders that change is still possible at any stage, but interventions among experienced teachers must be sustained and focus on critical examinations of practice to have lasting influence.

In order to address some of the psychometric difficulties (discriminant validity and factor analysis) associated with earlier efficacy measurements and begin bridging these theoretical disputes, Tschannen-Moran and Woolfolk Hoy (2000) created what is sometimes referred to as the *Ohio State Teacher Efficacy Scale (OSTES)* (Henson, 2001) or the *Teachers' Sense of Efficacy Scale (TSES)*. For the purposes of this study *TSES* was used as the identifier. The *TSES* has been used as the starting point for many other measures of teacher efficacy and is widely adapted. For example, it was used by Roberts and Henson to develop the *Self-Efficacy Teaching and Knowledge Instrument for Science Teachers* and Goddard et. al's *Collective Teacher Efficacy Scale* (Henson, 2001). It was consequently adapted for this study to focus on science education.

Teacher efficacy impacts implementation of instructional practices particularly scientific inquiry and other constructivist practices (Richardson & Liang, 2008). The authors proposed that instructors utilizing inquiry in science and math had higher efficacy and surveyed inquiry elements vs. efficacy among pre-service elementary teachers in an inquiry-based course three times using the Riggs and Enochs (1990) instrument. The authors found that the science course met the prescribed goals of inquiry-based learning, and resulted in an increase in participants' efficacy levels over time. Science teacher efficacy level was also examined in relation to professional development using the Riggs and Enochs (1990) instrument (Roberts, Henson, Tharp & Moreno, 2000). The authors examined archived data from 330 teachers over a seven-year period and administered the instrument before and after an in-service training. Educators scoring below 50 on the pretest were focused on with regard to length of training session, resulting in a statistically significant gain in efficacy for educators attending a 4-6 week program vs. a 2-3 week program. Low scoring pretest participants in the longer program had greater increases in efficacy levels. High scoring educators did not improve at a statistically significant level.

Changes in pre-service teacher self-efficacy after enrollment in a science methods course were also studied (Pontius, 1998). Participants were given two self-efficacy instruments, a modified version of the Dembo and Gibson (1985) scale and the Riggs and Enochs instrument (1990). The survey was given to 206 students with 195 useable responses. A positive correlation was found between the two scales, both of which were Likart type instruments. However, upon comparing science teaching efficacy and general teaching efficacy a negative correlation was discovered. Pre-service teachers with higher personal efficacy were found to have lower science teaching efficacy. Meanwhile those with higher science teaching efficacy were found to have lower general teaching efficacy. More research is clearly needed in subject-specific efficacy.

Smaller mixed methods studies have also yielded valuable information regarding teacher efficacy. The experiences of 19 pre-service elementary teachers responsible for organizing a science festival during practicum experiences were examined closely with regard to efficacy (Crowther & Cannon, 1998). Both qualitative and quantitative data were collected. Efficacy was measured using the Riggs and Enochs (1990) instrument and Haury's (1988) *Science Locus of Control Instruments I and II*. Over the course of the experience, self-efficacy improved. However, outcome expectancy gained only two points during the course of the 120 hours of contact time. Confidence level varied according to completion of a science methods course, concurrent enrollment in the course, or no enrollment in the course. Pre-service science teacher efficacy was also evaluated with regard to participation in the practicum experience (Wilson, 1994). Again both qualitative and quantitative data were collected with quantitative data gathered from the Riggs and Enochs (1990) instrument. As long as the field experiences were slowly introduced, well organized, logical, provided development and practice presenting lesson plans, utilized team/club participation, and were well planned, efficacy increased.

Educator beliefs about science teaching in context have also been studied (Lumpe, Haney, & Czerniak, 2000). The researchers conducted interviews with 130 educators and analyzed results to create the 26 item *Context Beliefs about Teaching Science* instrument. The instrument was given to 262 educators participating in long-term science professional development. The authors categorized beliefs into enable beliefs (the belief that something would enable student success) and likelihood beliefs (the belief that students would attain the construct in question or that a situation would occur). They found that enable beliefs were often greater than likelihood beliefs. Lower likelihood beliefs were attributed to lack of resources and commitment. Context belief scores were significantly correlated with the following factors: years of experience (positive correlation), number of science methods courses (positive correlation), number of teaching strategies, and time spent teaching science (Lumpe, Haney, & Czerniak, 2000)

The majority of efficacy studies focus on pre-service elementary teachers. However, a few studies examined both elementary and secondary pre-service science teachers' efficacy beliefs (Savran & Cakiroglu, 2003). The authors compared efficacy level and classroom management beliefs. The Riggs and Enochs (1990) instrument and the *Attitudes and Beliefs on Classroom Control Inventory* by Martin, Yin, and Baldwin (1998) were utilized. A sample of 646 pre-service teachers was utilized and overall participants held positive efficacy beliefs. Differences were found in educational level and secondary teachers held more positive efficacy beliefs than elementary teachers. The authors proposed that this was due to higher enrollment in science courses by secondary educators. No significant differences were found for gender, educational level, or classroom management. Because most studies regarding science teacher efficacy focus on the elementary population, more research such as this is needed on the secondary educator population. Therefore, the current study focused on the secondary science teacher population grades 6-12.

Summary

Constructivist instructional practices significantly influence classroom learning, from correcting student misconceptions (Bybee, et. al, 2006), to promoting critical thinking and problem solving (Vieira, Tenreiro-Vieira, & Martins, 2011). Appropriate practices also help students understand the role of science in society as well as the importance of empirical work and creativity (Abd-el-Khalick, Bell, & Lederman, 1998). Constructivist instructional practices promote student centered learning, as opposed to traditional teacher centered instruction (Woolfolk, 2010). Research regarding constructivist practice implementation such as this study therefore plays a crucial role in policy, professional development, and teacher preparation as the Next Generation Science Standards are put into practice (Huffman, Thomas, & Lawrenz, 2003; Yager, 2005).

A variety of school factors, including years of teaching experience, school socioeconomic status, class size, and instruction of AP or pre-AP courses may all influence selection of instructional practices. Unfortunately, studies regarding each of these factors have yielded mixed results over the years (Achi, 2011; Flower, 2010; Giglio, 2010; Haimson, 2011; Holley, 2008; Jensen, 2009; McCue, 2011; Payne, 2005; Picus, 2000; etc…). It was therefore necessary to examine these school factors in the context of this particular study regarding level of use of constructivist instructional practices and teacher efficacy level to determine what, if any, effect they had on the variables in question.

Finally, research on teacher efficacy level has also yielded mixed results over the years, but despite criticism has been shown to influence a variety of classroom activities including selection of instructional practices (Woolfolk Hoy, 2000). Efficacy research has several facets, including teacher efficacy and collective efficacy and has been shown to fluctuate significantly during the early portion of an educator's career (Henson, 2001; Woolfolk Hoy, 2000). An examination of teacher efficacy level was needed, therefore, in relation to level of use of constructivist instructional practices in order to determine if any differences existed between the levels.

CHAPTER 3: RESEARCH METHODS

The purpose of this chapter is to outline the research design and methods used in completion of this study. The chapter is organized around the following sections: research design, population, instrument, data collection, and data analysis.

Research Design

A mixed-methods design was used to conduct this study allowing collection of both qualitative and quantitative data. There are many benefits to a mixed methods design including clarification of results, lowering cost, shortening timelines, reduction in measurement error, and improving overall response rates (Dillman, Smyth, & Christian, 2009). Flexibility is another benefit of mixed methods designs (Patton, 2002). Mixing quantitative and qualitative elements allows a customized approach to data collection and triangulation of findings. Triangulation of data sources allows the investigator to collect data about the same topic and/or from the same group through a variety of methods yielding as much relevant data as possible. Patton discussed the need for the qualitative portion of mixed methods studies to remain open and flexible; allowing the researcher to explore emergent trends after data collection begins.

This mixed methods study occurred in two parts. Initial quantitative data collection occurred via online survey in a one-shot cross sectional manner (Fink, 2003). The quantitative survey provided descriptive data for one point in time, the 2011-2012 school year. The second part of the study consisted of qualitative follow-up telephone interviews to triangulate findings from the quantitative study (Patton, 2009). Respondents elaborated on instructional practices utilized in the classroom, teacher efficacy, and perceived barriers to implementation of constructivist instructional practices.

Population and Sample

The population for this study included West Virginia science teachers in public schools at the middle/junior high, and high school level (grades 6-12). West Virginia had 55 counties in 2011-2012 with approximately 125 high schools and 156 middle schools. According to the West Virginia Department of Education, there were approximately 1,898 science teachers for grades 6-12 in the 2011-2012 school year. A high school instructor population estimate was obtained using the total number of science teachers in three AAA high schools, three AA high schools, and three A high schools by calculating an average for each category. This average was multiplied by the total number of schools in that category (42, 43, and 40 respectively according to the 2011-2012 WVSSAC rules) to obtain an estimate of 836 high school science instructors. The high school population was subtracted from the state department population to obtain an estimate of middle school science instructors (1,062). The total population was included in the initial quantitative study.

Because not all potential science educators teach a science course each year, especially at the middle/junior high school level, an inclusion/exclusion question was included to indicate whether or not potential respondents were teaching a science course during the 2011-2012 school year. Only those teachers who indicated they were teaching a science course in the 2011-2012 school year were included in the study population.

Respondents for the qualitative portion of the study were recruited from the respondents to the initial quantitative survey. A question was placed at the end of the instrument asking each respondent if they were willing to participate in a follow up telephone interview by providing a telephone number and/or e-mail address. Of 23 respondents 15 were randomly chosen for telephone interviews.

Instrumentation

Multiple instruments were utilized in this study. The quantitative online survey, the *West Virginia Science Teacher Level of Constructivist Instructional Practice Survey (WVSTCIP)*, consisted of three portions, a demographic section, a section for level of use of selected constructivist instructional practices, and a section for teacher efficacy. The quantitative survey was a self-administered questionnaire, which provided respondents with questions to complete independently (Fink, 2003). The demographic section of the survey included basic questions with categories based on the *Teacher Quality Survey (TQS)* from Marshall University, 2011 and the WVSSAC classifications for the 2011-2012 school year. The complete instrument is included as Appendix A.

The second section of the quantitative survey solicited respondent information on the level of use of constructivist instructional practices in their science classrooms. This portion of the instrument was developed from a review of the literature and contained a list of research-based constructivist instructional practices with a Likart scale of 1-5 for participants to indicate their level of use for each practice (1= Never Used; 5= Very Frequent Use). The instrument produced a total score for level of use for constructivist practices.

Part three of the online survey focused on teacher efficacy and utilized a modified version of the *Teachers' Sense of Efficacy Scale (TSES)* by Tschannen-Moran and Woolfolk Hoy. Permission to use this survey was granted by Anita Woolfolk Hoy in July 2011 (Appendix B). The instrument provided a total score for efficacy and three sub-scores: Efficacy in Student Engagement (ESE), Efficacy in Instructional Practices (EIP), and Efficacy in Classroom Management (ECM) (Henson, 2001). The *TSES* was originally developed for use with pre-service teachers. The population was extended to in-service science teachers for the purpose of this study. Prompts were revised to refer to teaching science instead of general classroom teaching.

Tschannen-Moran and Woolfolk Hoy (2000) originally produced two forms of the *TSES*, a long and short. Both use nine point Likert-type scales. The long form contains 24 items and the short form 12 items. The long form of the survey was chosen for this study (Tschannen-Moran & Woolfolk Hoy, 2000). The *WVSTCIP* was pilot tested with a sub-set of science teachers (grades 6, 9, and 10-12) to validate and clarify the survey prompts. The purposes for the survey, individual items, and item clarity were analyzed. In addition, the instrument was submitted for expert review by a panel of higher education faculty with expertise in survey development. Several modifications including changes in wording to eliminate ambiguity and revisions to narrow the focus to science education, were made as a result of the pilot study and expert panel review.

The purpose of the follow-up telephone interviews was to collect additional data for use in validating the initial survey findings. An interview protocol which followed Borque and Fielder's (2003) *How to Conduct Telephone Surveys 2nd Edition*, part of

Fink's *The Survey Kit 2* (2003), was developed and utilized to guide the process. This protocol is provided in Appendix C.

Reliability and Validity

The *TSES* has been used in numerous studies for pre-service educators and as a basis for creating other instruments. In the original *TSES* survey, Tschannen-Moran and Woolfolk Hoy (2000) conducted two rounds of principle factor analysis from two independent samples and found three factors that explained 57% of the matrix of association variance. Convergent and discriminant validity coefficients supported construct validity. The three factors were: Efficacy in Student Engagement (ESE) (inter-factor correlation .59 and score reliability .82), Efficacy in Instructional Practices (EIP) (inter-factor correlation .60 and score reliability .81), and Efficacy in Classroom Management (ECM) (inter-factor correlation .64 and score reliability .72) (Henson, 2001).

The *TSES* authors found reliability with alpha of .94 and a standard deviation (SD) of .94 for the long form of the *TSES* and reliability with alpha of .90 and an SD of .98 on the short form of the *TSES*. Reliability for ESE with alpha .87 and SD 1.1 was found for the long form and alpha .81 with SD 1.2 for the short form. EIS reliability was found with alpha .91 and SD 1.1 on the long form and alpha .85 with SD 1.2 on the short form. Finally, ECM had a reliability of alpha .90 with SD 1.1 on the long form and alpha .86 with SD 1.2 on the short form (Tschannen-Moran & Woolfolk Hoy, 2000). Reliability and validity are related. Data must be reliable to be valid (Huck, 2008)

Construct validity for the *TSES* was examined using a comparison between the *TSES*, Rand Items, the Hoy and Woolfolk 10 item scale and the Gibson and Dembo *TES*

(Tschannen-Moran and Woolfolk Hoy, 2001). The *TSES* scores were positively correlated in one study with the Rand Items with r= .35 and .28 (p< .01), the Gibson and Dembo *TES* with r= .48 (p<.01) and a general teacher efficacy factor with r=.30 (p<.01). In a second study after further modification the *TSES* scores were positively correlated in one study with the Rand Items with r= .18 and .53 (p< .01), the Gibson and Dembo *TES* with r= .64 (p<.01) and a general teacher efficacy factor with r=.16 (p<.01). In addition, the authors measured discriminant validity through comparison with a survey of work alienation. Teacher efficacy was significantly negatively related to work alienation with r=.31 (p<.01). The survey was also field tested at Ohio State University by both teachers and teacher education students to collect feedback. The authors found that the validity results were good and the items represented the tasks associated with teaching.

Henson (2001) reported that Tschannen-Moran and Woolfolk Hoy (2000) later ran a second order factor analysis and found that the three sub-scores (ESE, EIS, and ECM) could be collapsed into one factor with pattern and structure coefficients from .74-.84, giving the instrument more general application. It can be used to assess the three sub-scores or for a general efficacy score and was used for both purposes in this study.

Validity for the instructional practices portion of the instrument was assessed via piloting the instrument with a subset of three science teachers of various grade levels (6, 9, 10-12). Participants were given the instrument to complete and the opportunity to discuss purpose and clarity of items and make suggestions for improvement in both verbal and written form (notes on the survey sheet). In addition, the survey was submitted to a panel of three higher education experts for review and feedback.

Data Collection

Following modification of the survey instrument after the expert review, the instrument was submitted to the Marshall University Institutional Review Board (MU IRB) for approval. IRB approval was granted on May 4, 2012 (Appendix E). An initial contact e-mail introducing the study and requesting that the survey link be forwarded to any instructor in their building teaching one or more science courses in the 2011-2012 school year was sent to the middle/junior high and high school principals on May 7, 2012. The principals were e-mailed utilizing the email addresses posted to the West Virginia Department of Education website for the 2011-2012 school year. Permission and instructions for use of this list of e-mails was granted April 23, 2012 (Appendix B).

The online survey link was sent via SurveyMonkey to principals on May 9, 12, 21, and 30, 2012 in a message designed to be easily forwarded to teachers (Appendix D). By forwarding the link to teachers the principal granted permission for participation. Teacher participation in the study indicated consent as per the cover letter included on the first page of the survey. Results were collected in SurveyMonkey and downloaded into SPSS. The quantitative survey was closed on June 11, 2012.

There were no required questions in the survey; respondents could skip questions, move forward and back in the survey answering questions in order of preference, or quit at any time. However, the nature of the survey resulted in missing data. An operational decision was made to include only data sets in which respondents answered 80% of the questions in the section under analysis (instructional practices and/or efficacy). Failure to answer 80% of the questions resulted in omission of that set from analysis. Based on these criteria (the inclusion/exclusion question and 80% minimum answer rate per section), the survey yielded 201 total responses with 190 useable responses.

Survey participants were given the opportunity to participate in qualitative follow-up interviews. Fifteen of the potential participants were contacted to participate in the follow-up interviews. Verbal consent for participation was obtained and participants were asked the questions on the interview guide. No identifying information was collected and responses were typed not recorded. Initial analysis of three interviews was conducted and these results were used to frame the final analysis of all interviews (Appendix J).

Data Analysis

Data analysis for the quantitative survey results was completed using the Statistical Package for the Social Sciences (SPSS) software. The following statistical analyses were performed to answer each research question.

For Research Question One, total constructivist instructional practice score was calculated by summing the individual responses for each of the 16 practices. A one sample t-test was conducted to compare this sample mean and that of each instructional practice to the mean score from a hypothetical normal distribution.

For Research Question Two, differences in level of use for each of the selected constructivist instructional practices and the total implementation score were analyzed based on selected demographic variables. An independent samples t-test was used to determine if significant differences existed in the level of use for each practice and the total level of use of constructivist practices based on school level (middle vs. high school) and whether or not an instructor taught an AP or pre-AP course in the preceding five years (including 2011-2012) by comparing the means from the two groups. A one-way Analysis of Variance (ANOVA) was used to determine if significant differences existed in the level of constructivist practice implementation for each practice and the total, based on participants' total years of teaching experience, years of teaching science, school SES level, size of the student population, and number of students in the science classroom.

For Research Question Three, the total efficacy score was calculated by summing the 24 individual efficacy prompts. A one sample t-test was conducted to compare this sample mean as well as individual prompts to the mean score from a hypothetical normal distribution. The 24 prompts were divided into three groups of eight to obtain efficacy sub-scores for Efficacy in Student Engagement (ESE), Efficacy in Instructional Practice (EIP), and Efficacy in Classroom Management (ECM). A one sample t-test was conducted to compare these sub-score means to the hypothetical mean score as well.

For Research Question Four, differences in science teacher efficacy for the total efficacy score (TE) and three efficacy sub-scores (ESE, EIP, and ECM) were analyzed based on demographic variables. An independent samples t-test was used to determine if significant differences existed in TE and the three sub-scores for school level (middle school vs. high school) and whether or not an instructor taught an AP or pre-AP course in the preceding five years including the 2011-2012 school year by comparing the means from the two groups. A one-way Analysis of Variance (ANOVA) was used to determine if a significant difference existed in TE or the sub-scores based on participants' total years of teaching experience, years of teaching science, school SES level, size of the student population, and the number of students in the science classroom.

For Research Question Five, the total constructivist practice score, 16 individual constructivist practice scores, total efficacy score, and three efficacy sub-scores were compared using a Pearson Product-Moment Correlation to determine if a significant relationship existed. Holcomb's (2006) categories of relationship strength were used in each of these comparisons: 0.00 = no relationship, .01-.24 = weak, .25-.49 = moderate, .50-.74 = moderately strong, .75-.99 = very strong, and 1.00 = perfect.

The results from the follow-up interviews were analyzed using emergent category analysis (Zhang & Wildemuth, 2009). Responses were categorized by common themes, allowing analysis of the qualitative data for emergent trends and corroboration of results.

Sections two and three of the quantitative survey (constructivist instructional practices and teacher efficacy) were examined for reliability using internal consistency, or the degree to which the items measure the same construct (Pallant, 2007) using Cronbach's alpha coefficient. Cronbach's alpha was performed for each of the 16 constructivist instructional practices, the individual efficacy prompts, total efficacy, and the three efficacy sub-scores (ESE, EIP, and ECM).

Limitations

Due to the subject specific training provided to science educators, the results of this analysis are limited to science teachers in West Virginia middle/junior high and high schools and are not generalizable to other educator populations. Limitations associated with sample size may also affect results. The efficacy portion of the instrument was also designed for pre-service elementary teachers although the target population consisted of in-service secondary teachers.

CHAPTER 4: FINDINGS

The purpose of this study was to determine the difference, if any, between teacher efficacy level and the level of use of selected, constructivist, instructional practices in science classrooms in West Virginia. The purpose of this chapter is to present and discuss study findings. This chapter is organized into the following sections: data collection, demographics (participant and school), major findings for each of the five research questions, ancillary findings, and a summary of findings.

Data Collection

The study was a mixed methods design with a one-shot cross sectional survey and follow up interviews. Initial permission (Appendix F) was granted by the MU IRB May 4, 2012. Following IRB approval, an introductory email (Appendix D) was sent to the state's 125 public high school and 156 public middle school principals on May 7, 2012. The email introduced the survey and requested assistance with distribution of the electronic survey to science teachers via SurveyMonkey. On May 9, 2012, the survey link was sent to 123 high school principals (two principals declined to participate) and 156 middle school principals. Follow up requests were sent May 9, 14, 21, and 30, 2012 (Appendix D). Two hundred and one (N = 201) teachers responded to the survey. Data collection was closed on June 11, 2012.

Of the 201 total responses, 190 responses were deemed usable. Usability was determined by two inclusion criteria. The first question of the survey asked the respondent to indicate whether or not they taught one or more science courses in the 2011-2012 school year. Only respondents answering "yes" to this question were included in the analysis. The second inclusion criterion was completion of 80% of the survey questions in the instructional practices and teacher efficacy portions of the survey.

Participant Characteristics

The participants in this study were teachers in West Virginia who taught one or more science courses in the 2011-2012 school year in one of the state's public middle, junior high, or high schools. Part one of the survey requested that teachers indicate the school level at which they taught in 2011-2012, total years of teaching experience, years of teaching science, and if they taught an AP or pre-AP course.

A slightly larger percentage of high school teachers, 52.1% (n = 99), than middle school teachers, 46.8% (n = 89), responded to the survey. The largest percentage of respondents, 29.5% (n = 56), had five or fewer total years of teaching experience. And the smallest percentage of respondents, 10.0% (n = 19), had 16-20 years of experience. The largest group of respondents, 34.2% (n = 65), had five or fewer years of science teaching experience and the smallest group, 7.9% (n = 15), had 21-25 years teaching science. The data on respondent years of teaching experience are presented in Table 1.

Respondents were also asked to indicate the subject or subjects they taught (general science, chemistry, biological science, environmental or earth science, physical science, or physics) in 2011-2012. Over half of the respondents, 51.6% (n = 98), taught general science, followed by biological sciences, 32.6% (n = 62). The fewest number of respondents taught physics, 13.2% (n = 25). These data are presented in Table 1.

Table 1

Subjects Taught by Participants and Years of Teaching Experience

Characteristic	n	%
*Subject Taught		
General Science	98	51.6
Chemistry	38	20.0
Biological Science	62	32.6
Environmental Science or Earth Science	34	17.9
Physical Science	48	25.3
Physics	25	13.2
Years Teaching		
5 or less	56	29.6
6 – 10	28	14.7
11 – 15	24	12.6
16 – 20	19	10.0
21 – 25	21	11.1
26+	42	22.1
Years Teaching Science		
5 or less	65	34.2
6 – 10	34	17.9
11 – 15	25	13.2
16 – 20	18	9.5
21 – 25	15	7.9
26+	33	17.4

N = 190 *Duplicated Count

Respondents were also asked if they had taught one or more Advanced Placement (high school) or Pre-Advanced Placement (middle school) courses in 2011-2012. Thirty-seven respondents (19.5%) indicated that they had taught at least one such course.

School Characteristics

Survey participants were asked three school demographic questions: school SES level based on federal guidelines for percent of students eligible for free and reduced lunch; the size of the student population based on the WVSSAC school classification system (A, AA, and AAA); and the number of students in an average science class at the school. These data are presented in Table 2.

Table 2

School Demographics

Characteristic	n	%
Students Eligible for Free and Reduced Lunch (SES Level)		
Less than 35%	9	4.7
36-50%	57	30.0
51-75%	82	43.2
76% +	29	15.3
Number of Students in School		
339 or less (A)	26	13.7
340-618 (AA)	79	41.6
619 + (AAA)	84	44.2
Typical Number of Students in Science Classroom		
11-15	5	2.6
16-20	32	16.8
21-25	102	53.7
26 +	50	26.3

N=190

More than half (58.5%, n = 111) of the respondents reported student eligibility for free and reduced lunch at 51% or greater. More than 85% of the respondents were from

AA (41.6%, n = 79) or AAA (44.2%, n = 84) schools. Eight of ten respondents reported the typical number of students in the science classes in their schools contained 21-25 (53.7%, n = 102) or 26+ (26.3%, n = 50) students.

Findings

Five major research questions were addressed during this study. This section presents the findings for each of the major research questions and includes sections addressing ancillary findings, and instrument reliability. A final section provides a summary of the findings.

Levels of Use of Selected Constructivist Instructional Practices

Participating science teachers were asked to indicate their level of use of each of the 16 instructional practices on a Likert scale of 1 – 5, with 1 = Never, 2 = Hardly Ever, 3 = Sometimes, 4 = Frequently, and 5 = Very Frequently. A one sample t-test was conducted to compare the sample mean for each instructional practice to the mean score (M = 3.0, R = 1.0-5.0) from a hypothetical normal distribution. A total constructivist instructional practice score was calculated for each subject by summing the individual responses for each of the 16 practices. A one-sample t-test was used to compare this total mean score with the mean (M = 48, R = 16-80) from a hypothetical normal distribution.

Analysis of respondent mean scores for the 16 constructivist instructional practices yielded three levels of response. Six strategies had mean scores greater than 3.5. Four strategies had mean scores that fell between 3.0-3.49. Six strategies had mean scores less than 3.0. Means ranged from 2.26 - 3.92

Instructional strategies with means greater than 3.60 included: grouping students in order to divide a larger task and work together to complete it (M = 3.60, SD = .822, $p<.001$), providing ideas related to a topic and form new connections and deeper understanding of the topic (M = 3.92, SD = .707, $p<.001$), and pooling collective student knowledge in groups or class wide to share ideas and clarify understanding (M = 3.69, SD = .757, $p<.001$). Instructional strategies with means greater than 3.5 also included providing students with examples and attributes of a word/topic which students utilize to form a definition (M = 3.58, SD = .925, $p<.001$), asking questions of students and lead students to ask questions of one another (M = 3.53, SD = .943, $p<.001$), and identifying a theme, essential question, or big idea and have students use supplemental material to explore the topic (M = 3.52, SD = .960, $p<.001$).

Instructional strategies with means ranging from 3.20 - 3.49 included: requiring students to work together to solve a problem that mimics one found in the real world (M = 3.49, SD = .923, $p<.001$), requiring students to work at their own pace through a cycle of questioning, seeking answers, and reflection (M = 3.27, SD = .838, $p<.001$), and requiring students to formulate and solve a problem with a focus on creating a concrete product (M = 3.31, SD = .911, $p<.001$). Having students list all important facts, participants, actions, feelings, reasons, and alternative solutions to problems also had a mean greater than 3.0 (M = 3.14, SD = .831, $p<.05$).

Strategies with means less than 3.0 included: having students assume the roles of others and experience new perspectives to solve a problem (M = 2.65, SD = .887, $p<.001$), alternating roles with students to summarize, predict, and clarify passages (M = 2.73, SD = .938, $p<.001$), and requiring students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…(M = 2.26, SD =.828, p<.001). Allowing students to choose a topic or a problem, look for causes, supports, and effects also resulted in a mean less than 3.0 (M = 2.77, SD =.822, p<.001).

When a one-sample t-test was used to compare the mean score (3.0) from a hypothetical normal distribution to the sample mean for each item, only two of the six practices with means of less than 3.0 were not found to be statistically significant. The two practices were having students list as many items as possible related to a topic and grouping/regrouping them by similarities (M = 2.92, SD = .895, p = .234), and providing students with a topic to describe, create analogies, identify conflicts, and evaluate findings (M = 2.95, SD = .941, p = .466).

A one sample t-test was performed for the total level of constructivist practice implementation. The total level of practice was obtained by summing each of the scores for the individual practices and calculating the overall mean. This value (M = 50.84, SD = 8.65) was compared to the mean (M = 48, R = 16-80) for a hypothetical normal distribution and was found to be significant at the p <.001 level (t = 4.326). These data are provided in Table 3.

Table 3

Level of Use of Selected Constructivist Instructional Practices by Secondary Science Teachers

Prompt	M	SD	t-value
1. Group students in order to divide a larger task and work together to complete it.	3.60	.822	9.724***
2. Provide ideas related to a topic and form new connections and deeper understanding of the topic.	3.92	.707	17.224***
3. Pool collective student knowledge in groups or class wide to share ideas and clarify understanding.	3.69	.757	11.983***
4. Provide students with examples and attributes of a word/topic which students utilize to form a definition.	3.58	.925	8.265***
5. Have students list as many items as possible related to a topic and group/regroup them by similarities.	2.92	.895	-1.193
6. Ask questions of students; lead students to question one another.	3.53	.943	7.318***
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate the result.	2.95	.941	-.731
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.77	.822	-3.607***
9. Have students list all important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	3.14	.831	2.197*
10. Identify a theme, essential question, or big idea and have students use supplemental material to explore the topic.	3.52	.960	7.089***
11. Have students assume the roles of others and experience new perspectives to solve a problem.	2.65	.887	-5.191***
12. Alternate roles with students to summarize, predict, and clarify	2.73	.938	-3.701***
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…	2.26	.828	-11.555***
14. Require students to work together to solve a problem that mimics one found in the real world.	3.49	.923	6.879***
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	3.27	.838	4.275***
16. Require students to formulate and solve a problem with a focus on creating a concrete product.	3.31	.911	4.423***

***p <.001, **p <.01, *p <.05: Scale: 1=Never 2=Hardly Ever 3= Sometimes 4=Frequently 5=Very Frequently; N= 190 R = 16-80

Levels of Use Based on Demographic Variables

Survey respondents were initially asked a series of demographic questions. This section examines the differences in level of use of constructivist instructional practices based on their responses to selected demographic variables. The differences in levels of use for each instructional practice and the total level of use score for school level and AP instruction were investigated using an independent samples t-test. The differences in levels of use for each instructional practice and the remaining demographic variables were investigated using Analysis of Variance (ANOVA).

An independent samples t-test was used to determine if significant differences existed in the level of use of constructivist practices and school level (middle school or high school). Teachers indicating that they taught both middle school and high school level courses were collapsed into the middle school category. The analysis for two of the individual practices, having students assume the role of others to experience new perspectives and solve problems (High School: $M = 2.80$, $SD = .808$ Middle School: $M = 2.48$, $SD = .926$, $p < .05$) and alternating roles with students to summarize, predict, and clarify passages (High School: $M = 2.94$, $SD = .827$ Middle School: $M = 2.51$, $SD = .967$, $p < .01$), resulted in significantly different levels of use between middle and high school teachers with middle school significantly higher for both practices. There were no significant differences in level of use based on school level for any other individual instructional practices or the total use level. These data are provided in Table 4

Table 4

Mean Differences between School Level and Level of Use of Constructivist Instructional Practices (Individual and Total)

	Middle School		High School		
Constructivist Practice	M	SD	M	SD	t
1. Group students in order to divide a larger task and work together to complete.	3.63	.794	3.56	.840	.546
2. Provide ideas related to a topic and form new connections and deeper understanding.	3.90	.713	3.92	.699	-.200
3. Pool collective student knowledge, group, share ideas, clarify understanding.	3.76	.746	3.61	.755	1.292
4. Provide students with examples/ attributes of a word/topic to form a definition.	3.56	.851	3.60	.985	-.282
5. Have students list as many items as possible related to a topic and group/regroup them by similarities.	3.00	.775	2.83	.986	1.220
6. Ask questions of students and lead students to ask questions of one another.	3.61	.864	3.44	.999	1.206
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate the results.	2.99	.981	2.90	.905	.614
8. Allow students to choose a topic or problem, locate cause, effect and supports.	2.85	.739	2.69	.882	1.321
9. Have students list all important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	3.18	.687	3.08	.927	.838
10. Identify a theme, essential question, or big idea and have students use supplemental material to explore the topic.	3.65	.873	3.39	1.013	1.789
11. Have students assume the roles of others; use new perspectives to solve problems.	2.80	.808	2.48	.926	2.413*
12. Alternate roles with students to summarize, predict, and clarify passages.	2.94	.827	2.51	.967	3.056**
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…	2.34	.830	2.18	.824	1.248
14. Require students to work together to solve a real world problems	3.46	.899	3.49	.939	-.187
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	3.38	.784	3.17	.877	1.691
16. Require students to formulate and solve a problem with focus on creating a product.	3.30	.748	3.29	1.030	.115
Total Constructivist Practice Level	51.78	8.006	49.74	8.865	1.575

n = 84 (Middle School) n = 90 (High School) $*p < .05$ $**p < .01$

A one-way Analysis of Variance (ANOVA) was used to determine if significant differences existed in the level of constructivist practice implementation based on participants' total years of teaching experience. Two practices, alternating roles with students to summarize, predict, and clarify passages (5 or less: M = 2.94, SD = .904; 6-10: M = 2.39, SD = .941; 11-15: M = 2.71, SD = .624; 16-20: M = 3.38, SD = 1.204; 21-25: M = 2.47, SD = .841; 26+: M = 2.51, SD = .919; f = 3.535, $p<.05$) and requiring students to explore situations outside the classroom in museums, gardens, with guests, etc… (5 or less: M = 1.92, SD = .821; 6-10: M = 2.22, SD = .850; 11-15: M = 2.26, SD = .810; 16-20: M = 2.76, SD = .664; 21-25: M = 2.29, SD = .849; 26+: M = 2.51, SD = .731; f = 4.011, $p<.05$) were significantly different based on years of experience. The highest mean score was reported for the 16-20 years of experience group for both practices. There were no statistically significant differences in level of use of constructivist practices based on total years of teaching experience for any other individual instructional practices or the total level of use. These data are provided in Table 5.

Table 5

Mean Differences in Level of Use of Constructivist Instructional Practices Based on Total Years of Teaching Experience

	5 or fewer		6-10		11-15		16-20		21-25		26 +		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	*f*
1. Group students to divide a larger task; work together to complete	3.75	.806	3.48	.918	3.54	.721	3.67	.686	3.61	.916	3.47	.862	.704
2. Provide ideas related to a topic, form new connections and deeper understanding.	3.96	.678	4.00	.659	3.79	.658	4.00	.707	3.74	.733	3.95	.804	.561
3. Pool collective knowledge in groups or class wide to share ideas and clarify.	3.70	.749	3.75	.737	3.63	.647	3.94	.827	3.53	.612	3.63	.883	.656
4. Provide students with examples and attributes for students utilize to form a definition.	3.63	.871	3.63	.824	3.50	.834	4.12	.928	3.22	.878	3.49	1.070	1.883
5. Have students list as many items as possible and group/regroup them by similarities.	2.96	.816	2.63	1.056	3.00	.834	3.12	.993	2.89	.963	2.92	.862	.747
6. Ask questions of students and lead students to ask questions of one another.	3.67	1.013	3.21	.884	3.57	.728	3.76	1.091	3.39	.778	3.49	.989	1.088
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate.	2.87	.841	3.00	.953	3.00	.853	3.18	1.380	2.63	.831	3.05	.941	8.28
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.73	.819	2.67	1.007	2.88	.741	2.82	.883	2.63	.895	2.89	.699	.454

Constructivist Practices	5 or fewer M	5 or fewer SD	6-10 M	6-10 SD	11-15 M	11-15 SD	16-20 M	16-20 SD	21-25 M	21-25 SD	26+ M	26+ SD	*f*
9. Have students list important facts, participants, actions, feelings, reasons, and solutions.	3.17	.760	3.25	.737	2.88	.797	3.41	1.121	2.84	.765	3.22	.854	1.527
10. Identify a theme, essential question, or big idea; use supplemental material to explore	3.73	.981	3.50	.834	3.42	.776	3.71	1.312	3.21	.855	3.39	.964	1.188
11. Have students assume the roles of others to experience new perspectives, solve problems	2.70	.863	2.71	.908	2.58	1.018	2.71	.985	2.53	.841	2.61	.838	.176
12. Alternate roles with students to summarize, predict, and clarify passages.	2.94	.904	2.39	.941	2.71	.624	3.38	1.204	2.47	.841	2.51	.919	3.535*
13. Require students to explore situations outside the classroom - museums, gardens, etc...	1.92	.821	2.22	.850	2.26	.810	2.76	.664	2.29	.849	2.51	.731	4.011*
14. Require students to work together to solve a real world problem	3.63	.864	3.48	.898	3.38	1.056	3.88	.806	3.11	.875	3.38	.953	1.690
15. Require students to work through questioning, seeking answers, and reflection.	3.37	.768	3.25	.847	3.13	.920	3.47	1.007	3.16	.834	3.22	.821	.550
16. Require students to formulate and solve a problem; create a concrete product.	3.38	.889	3.25	.989	3.33	.816	3.29	1.105	3.05	1.026	3.35	.824	.406
Total Level of Use	51.63	6.645	49.92	8.817	50.08	7.398	54.82	11.86	47.37	9.541	50.78	9.292	1.538

* $p < .05$ N = 190

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the level of constructivist practice implementation based on participants' years of teaching science. Only one practice, requiring students to explore situations outside the classroom in museums, gardens, with guest speakers, etc... was significant at the $p < .05$ level (5 or less: M = 2.00, SD = .823; 6-10: M = 2.21, SD = .876; 11-15: M = 2.35, SD = .832; 16-20: M = 2.50, SD = .855; 21-25: M = 2.46, SD = .660; 26+: M = 2.57, SD = .728; f = 2.581, $p<.05$). The highest mean score was reported for the 26+ age group for this practice. There were no statistically significant differences in level of use of constructivist instructional practices based on total years of teaching science for any other individual instructional practices or the total implementation level score. These data are provided in Table 6.

Table 6

Mean Differences in Level of Use of Constructivist Instructional Practices Based on Years of Teaching Science

	5 or fewer		6-10		11-15		16-20		21-25		26 +		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	*f*
1. Group students to divide a larger task; work together to complete	3.69	.801	3.57	.858	3.48	.770	3.86	.864	3.73	.799	3.37	.850	1.118
2. Provide ideas related to a topic, form new connections and deeper understanding.	3.94	.698	3.93	.651	.853	3.04	1.036	.663	4.00	.535	3.97	.765	.233
3. Pool collective knowledge in groups/class to share ideas and clarify.	3.73	.728	3.76	.739	3.60	.816	3.71	.726	3.53	.743	3.67	.844	.276
4. Provide students with examples and attributes for students utilize to form a definition.	3.60	.848	3.62	.862	3.61	1.033	3.71	.994	3.47	.990	3.50	1.042	.165
5. Have students list as many items as possible and group/regroup them by similarities.	3.07	.892	2.69	.891	3.00	.905	2.79	1.122	2.73	.799	2.93	.828	.938
6. Ask questions of students and lead students to ask questions of one another.	3.68	.965	3.21	.819	3.59	.854	3.50	1.092	3.60	.828	3.47	1.042	1.064
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate.	2.87	.853	3.04	1.036	2.92	.881	3.00	1.468	2.73	.799	3.13	.860	.534
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.79	.789	2.69	.891	2.79	.884	2.64	1.008	2.67	.816	2.93	.691	.407

Constructivist Practices	5 or Fewer M	SD	6-10 M	SD	11-15 M	SD	16-20 M	SD	21-25 M	SD	26+ M	SD	*f*
9. Have students list important facts, participants, actions, feelings, reasons, and solutions.	3.20	.771	3.07	.651	3.00	.834	3.14	1.351	3.07	.704	3.23	.898	.328
10. Identify a theme, essential question, or big idea; use supplemental material to explore	3.70	.908	3.45	.870	3.50	.933	3.29	1.267	3.40	.910	3.41	1.053	.735
11. Have students assume the roles of others to experience new perspectives, solve problems	2.66	.870	2.76	.951	2.54	.977	2.43	.756	2.73	.884	2.67	.884	.355
12. Alternate roles with students to summarize, predict, and clarify passages.	2.90	.885	2.46	.962	2.96	.859	2.83	1.193	2.53	.915	2.53	.937	1.564
13. Require students to explore situations outside the classroom - museums, gardens, etc...	2.00	.823	2.21	.876	2.35	.832	2.50	.855	2.46	.660	2.57	.728	2.581*
14. Require students to work together to solve a real world problem	3.58	.850	3.54	.922	3.29	.999	3.50	1.092	3.67	1.047	3.30	.877	.716
15. Require students to work through questioning, seeking answers, and reflection.	3.36	.731	3.21	.774	3.22	1.085	3.14	1.099	3.47	.834	3.17	.791	.506
16. Require students to formulate and solve a problem; create a concrete product.	3.41	.844	3.07	.884	3.29	.908	3.14	1.351	3.40	1.121	3.37	.718	.694
Total Level of Use	51.56	6.477	49.86	8.327	50.13	10.38	50.43	13.97	50.87	8.374	51.10	8.957	.198

* $p < .05$ N = 173

An independent samples t-test was used to determine if significant differences existed in the level of constructivist practice implementation and whether or not an instructor taught an AP or pre-AP course in the 2011-2012 school year. Only one of the individual practices, pooling collective student knowledge in groups or class wide to share ideas and clarify understanding, was significant at the $p < .05$ level (AP: $M = 3.44$; $SD = .736$ No AP: $M = 3.75$; $SD = .753$; $t = -2.200$). The highest mean score was reported for the No AP group for this practice. There were no statistically significant differences in level of use based on AP instruction for any other individual instructional practices or the total implementation level score. These data are provided in Table 7.

Table 7

Mean Differences between AP and No AP Instruction and Level of Use of Constructivist Instructional Practices (Individual and Total)

	AP		No AP		
Constructivist Practice	M	SD	M	SD	*t*
1. Group students in order to divide a larger task and work together to complete.	3.56	..843	3.61	.819	-.375
2. Provide ideas related to a topic, form new connections and deeper understanding.	3.81	.624	3.95	.726	-1.192
3. Pool collective student knowledge in groups or class wide to share ideas and clarify understanding.	3.44	.735	3.75	.753	-2.200*
4. Provide students with examples and attributes of a word/topic which students utilize to form a definition.	3.50	1.082	3.61	.882	-.618
5. Have students list items related to a topic and group/regroup them by similarities.	2.67	.828	2.99	.903	-1.915
6. Ask questions of students and lead students to ask questions of one another.	3.28	.944	3.60	.935	-1.804
7. Provide students with a topic to describe, create analogies, identify conflicts & evaluate.	2.81	.889	2.99	.954	-1.061
8. Allow students to choose a topic/problem, look for causes/effects, and supports.	2.72	.944	2.79	.790	-.428
9. Have students list all important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	3.11	.950	3.15	.800	-.224
10. Identify a theme, essential question, or big idea and have students use supplemental material to explore topic.	3.28	1.003	3.59	.941	-1.655
11. Have students assume the roles of others and experience new perspectives.	2.51	.853	2.68	.895	-1.023
12. Alternate roles with students to summarize, predict, and clarify passages.	2.46	.886	2.80	.941	-1.966
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…	2.24	.890	2.27	.815	-.209
14. Require students to work together to solve real world problems.	3.31	1.009	3.53	.896	-1.319
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	3.00	.926	3.35	.802	-2.225
16. Require students to formulate and solve a problem with a focus on creating a product.	3.33	.956	3.30	.902	.199
Total Constructivist Practice Level	48.75	9.581	51.39	8.334	-1.641

n = 36 (AP) n = 137 (No AP) *$p < .05$ N = 190

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the level of use of constructivist practices based on participants' school SES level (as measured with a self-reported question). No significant differences based on SES level were found for any individual practice or for the total level of use of constructivist instructional practices and school SES level ($f = .479$). These data are provided in Table 8.

Table 8

Mean Differences between School SES Level and Level of Use of Constructivist Instructional Practices (Individual and Total)

	< 35%		35-50%		51-75%		76 + %		Totals		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	M	SD	*f*
1. Group students to divide a larger task; work together to complete	3.56	.882	3.58	.825	3.66	.861	3.59	.694	3.62	.819	.131
2. Provide ideas related to a topic, form new connections and deeper understanding.	4.11	.601	3.88	.758	3.88	.707	4.00	.679	3.92	.711	.436
3. Pool collective knowledge in groups or class wide to share ideas and clarify.	3.78	.667	3.65	.789	3.68	.658	3.63	.926	3.67	.744	.096
4. Provide students with examples and attributes for students utilize to form a definition.	3.56	1.130	3.57	.900	3.55	.859	3.70	1.068	3.58	.917	.198
5. Have students list as many items as possible and group/regroup them by similarities.	2.67	.866	2.80	.939	3.00	.864	3.04	.854	2.93	.886	.896
6. Ask questions of students and lead students to ask questions of one another.	3.78	.833	3.45	.986	3.53	.949	3.73	.962	3.55	.955	.667
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate.	3.22	1.093	2.86	.990	2.99	.866	3.04	.999	2.97	.935	.499
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.56	.726	2.75	.868	2.82	.839	2.89	.698	2.79	.818	.455
9. Have students list important facts, participants, actions, feelings, reasons, and solutions.	3.00	.707	3.20	.895	3.23	.841	3.00	.555	3.17	.811	.700
10. Identify a theme, essential question, or big idea; use supplemental material to explore	3.88	.991	3.40	1.030	3.51	.982	3.78	.751	3.54	.966	1.252

Constructivist Practices	<35% M	<35% SD	35-50% M	35-50% SD	51-75% M	51-75% SD	76+ M	76+ SD	Totals M	Totals SD	*f*
11. Have students assume the roles of others to experience new perspectives, solve problems	2.89	.782	2.55	1.006	2.66	.857	2.80	.816	2.66	.895	.657
12. Alternate roles with students to summarize, predict, and clarify passages.	3.11	.928	2.53	.981	2.79	.937	3.00	.707	2.76	.928	2.055
13. Require students to explore situations outside the classroom - museums, gardens, etc...	2.78	.667	2.38	.822	2.21	.822	2.15	.864	2.28	.828	1.758
14. Require students to work together to solve a real world problem	3.33	1.000	3.44	.861	3.58	.970	3.63	.792	3.53	.907	.483
15. Require students to work through questioning, seeking answers, and reflection.	3.67	.707	3.25	.796	3.25	.891	3.27	.667	3.28	.819	.724
16. Require students to formulate and solve a problem; create a concrete product.	3.56	.726	3.31	.990	3.35	.839	3.30	.912	3.34	.889	.213
Total Level of Use	53.00	9.811	50.06	8.983	51.35	8.778	51.74	5.855	51.10	8.456	.479

N = 190

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the level of use of constructivist practices based on participants' school size (as measured with a self-reported question) based upon the WVSSAC school classification system for the 2011-2012 school year. (A = 339 or fewer students, AA = 340-618 students, AAA = 619 or more students). Only one individual practice was significant at the $p < .05$ level, requiring students to formulate and solve a problem with focus on creating a concrete product (A: M = 3.08; SD = .891; AA: M = 3.53; SD = .944; AAA: M = 3.20; SD = .894 Totals: M = 3.31; SD = .908 f = 3.570; $p < .05$). The highest mean score for this practice occurred in the AA category (M = 3.53; SD = .944) but the lowest mean was the A category (M = 3.08; SD = .891). There were no statistically significant differences in level of use based on school size for any other individual instructional practices or the total implementation level score. These data are provided in Table 9.

Table 9

Mean Differences between School Size (A, AA, and AAA) Based on Level of Use of Constructivist Instructional Practices (Individual and Total)

	A		AA		AAA		Totals		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	*f*
1. Group students to divide a larger task; work together to complete	3.50	.648	3.70	.835	3.55	.863	3.61	.823	.893
2. Provide ideas related to a topic, form new connections and deeper understanding.	3.85	.784	4.01	.686	3.87	.695	3.93	.705	.962
3. Pool collective knowledge in groups or class wide to share ideas and clarify.	3.77	.765	3.77	.778	3.58	.732	3.69	.757	1.339
4. Provide students with examples and attributes for students utilize to form a definition.	3.38	.898	3.72	.906	3.55	.934	3.59	.920	1.477
5. Have students list as many items as possible and group/regroup them by similarities.	2.88	.816	3.06	.961	2.83	.828	2.93	.885	1.272
6. Ask questions of students and lead students to ask questions of one another.	3.58	.902	3.58	.991	3.47	.925	3.53	.945	.259
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate.	2.80	.764	3.03	1.049	2.93	.890	2.95	.941	.570
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.92	.688	2.83	.884	2.68	.804	2.78	.822	1.032
9. Have students list important facts, participants, actions, feelings, reasons, and solutions.	3.19	.801	3.24	.892	3.04	.774	3.15	.828	1.149

Constructivist Practices	A M	A SD	AA M	AA SD	AAA M	AAA SD	Totals M	Totals SD	*f*
10. Identify a theme, essential question, or big idea; use supplemental material to explore	3.35	.797	3.66	1.031	3.46	.944	3.52	.962	1.312
11. Have students assume the roles of others to experience new perspectives, solve problems	2.73	.874	2.60	.883	2.67	.905	2.65	.888	.214
12. Alternate roles with students to summarize, predict, and clarify passages.	2.69	.838	2.84	.971	2.65	.943	2.73	.938	.749
13. Require students to explore situations outside the classroom - museums, gardens, etc...	2.21	.833	2.33	.880	2.23	.773	2.27	.825	.315
14. Require students to work together to solve a real world problem	3.20	1.000	3.67	.928	3.43	.857	3.49	.918	2.851
15. Require students to work through questioning, seeking answers, and reflection.	3.40	.816	3.33	.829	3.20	.849	3.28	.835	.746
16. Require students to formulate and solve a problem; create a concrete product.	3.08	.891	3.53	.944	3.20	.849	3.31	.908	3.570*
Total Level of Use	50.00	7.483	52.51	9.294	49.83	8.074	50.95	8.563	2.003

*p < .05 N = 172

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the level of use of constructivist practices based on the average size of science classes in the participants' schools (as measured with a self-reported question). Class size categories were 20 or fewer students, 21-25 students, and 26+ students. Only one individual practice was significant at the $p < .05$ level, requiring students to formulate and solve a problem with focus on creating a concrete product (20 or fewer: M = 2.59; SD = .896 21-25: M = 3.03; SD = .939 26+: M = 2.96; SD = .767 Totals: M = 2.92; SD = .895 f = 3.291; $p < .05$). The highest mean score for this practice occurred in the 21-25 student group (M = 3.30; SD = .939). There were no statistically significant differences in level of use based on class size for any other individual instructional practices or the total implementation level score. These data are provided in Table 10.

Table 10

Mean Differences between Size of Typical Science Classes Based on Level of Use of Constructivist Instructional Practices (Individual and Total)

	20 or Fewer		21-25		26+		Totals		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	*f*
1. Group students to divide a larger task; work together to complete	3.49	.768	3.57	.902	3.76	.679	3.60	.824	1.220
2. Provide ideas related to a topic, form new connections and deeper understanding.	3.89	.737	3.86	.692	4.07	.712	3.92	.709	1.359
3. Pool collective knowledge in groups or class wide to share ideas and clarify.	3.62	.828	3.69	.756	3.74	.713	3.69	.757	.246
4. Provide students with examples and attributes for students utilize to form a definition.	3.49	.961	3.64	.932	3.56	.893	3.58	.925	.390
5. Have students list as many items as possible and group/regroup them by similarities.	2.59	.896	3.03	.939	2.96	.767	2.92	.895	3.291*
6. Ask questions of students and lead students to ask questions of one another.	3.30	.968	3.60	.904	3.58	.988	3.53	.943	1.450
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate.	2.70	.909	2.99	.911	3.07	1.009	2.95	.941	1.713
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.70	.878	2.75	.797	2.89	.832	2.77	.822	.624
9. Have students list important facts, participants, actions, feelings, reasons, and solutions.	3.14	.918	3.14	.811	3.13	.815	3.14	.831	.002

2	20 or Fewer		21-25		26+		Totals		
Constructivist Practices	M	SD	M	SD	M	SD	M	SD	*f*
10. Identify a theme, essential question, or big idea; use supplemental material to explore	3.43	1.068	3.46	.958	3.72	.854	3.52	.960	1.268
11. Have students assume the roles of others to experience new perspectives, solve problems	2.59	.896	2.56	.783	2.86	1.047	2.65	.887	1.806
12. Alternate roles with students to summarize, predict, and clarify passages.	2.67	.894	2.77	.906	2.70	1.047	2.73	.938	.187
13. Require students to explore situations outside the classroom - museums, gardens, etc...	2.29	.836	2.24	.794	2.28	.908	2.26	.828	..061
14. Require students to work together to solve a real world problem	3.41	.927	3.50	.951	3.52	.876	3.49	.923	.185
15. Require students to work through questioning, seeking answers, and reflection.	3.38	.721	3.21	.814	3.31	.973	3.27	.838	.581
16. Require students to formulate and solve a problem; create a concrete product.	3.30	.968	3.29	.946	3.36	.802	3.31	.911	.090
Total Level of Use	49.73	8.977	50.79	8.622	51.87	8.492	50.84	8.646	.621

$p < .05$ N = 190

Teacher Efficacy Levels

Twenty-four efficacy prompts were listed in the third part of the survey. Participants were asked to use a Likert scale of 1 – 9 with 1 = Nothing and 9 = A Great Deal to indicate their level of efficacy. A one sample t-test was used to compare the sample mean for each practice to the mean score (M = 5.0) from a hypothetical normal distribution for each of the 24 practices.

The 24 items were also grouped into three subcategories based on type of efficacy. Eight strategies were included in each category. Items 1, 2, 4, 6, 9, 12, 14, and 22 fall into the Efficacy in Student Engagement (ESE) category. Items 7, 10, 11, 17, 18, 20, 23, and 24 fall into the Efficacy in Instructional Practice (EIP) category. Items 3, 5, 8, 13, 15, 16, 19, and 21 fall into the Efficacy in Classroom Management (ECM) category. Total scores for each category were calculated by summing the responses to the eight prompts in that category and performing a one-sample t-test to compare each total category mean to hypothetical mean score (M = 40; Range = 8-72).

Finally, a total efficacy score was calculated for each subject by summing the responses to the 24 prompts. A total efficacy score of 169.86 (SD = 25.668) with t-value 26.420 was obtained. A one sample t-test comparing the sample total mean score to the mean score (M = 118; Range = 24-216) from a hypothetical normal distribution was conducted resulting in significance at the $p<.001$ level.

Initial analysis of respondent mean scores for the 24 efficacy items revealed three levels of response. Ten efficacy prompts resulted in mean values less than 7.0. Ten had mean values from 7.0-7.49. Four had mean values greater than 7.5. Each of the 24 prompts yielded significance at the $p = < 0.001$ confidence level. The prompts with mean values less than 7.0 included: getting through to the most difficult students (M = 5.99, SD = 1.789); helping students think critically (M = 6.95, SD = 1.399); motivating students who show low interest n school work (M = 6.09, SD = 1.772); getting students to believe they can do well in school (M = 6.99, SD = 1.437); helping students value learning (M = 6.82, SD = 1.514); fostering student creativity (M = 6.95, SD = 1.579); improving the understanding of failing students (M = 6.45, SD = 1.666); calming a student who is disruptive or noisy (M = 6.95, SD = 1.661); assisting families in helping their children do well in school (M = 5.95, SD = 1.941); and implementing alternative strategies in your classes (M = 6.96, SD = 1.515).

The ten prompts with mean values from 7.0-7.49 included: controlling disruptive behavior (M = 7.23, SD = 1.684); gauging student comprehension of what you have taught (M = 7.46; SD = 1.139); crafting good questions for your students (M = 7.41; SD = 1.187); getting children to follow classroom rules (M = 7.47; SD = 1.593); establishing classroom management systems with groups of students (M = 7.38; SD = 1.550); adjusting your lessons to the proper level for individual students (M =7.07; SD = 1.564); using a variety of assessment strategies (M = 7.49; SD = 1.489); keeping a few problem students from ruining an entire lesson (M = 7.21; SD = 1.730); responding to defiant students (M = 7.04, SD = 1.608); and providing appropriate challenges for very capable students (M = 7.33; SD = 1.215). Many of the classroom management prompts fell into this level of response.

Four prompts resulted in mean values greater than 7.5. The highest level of efficacy was reported for making expectations clear about student behavior (M = 8.12;

SD = 1.167; *p* <.001). Other mean efficacy levels greater than 7.5 were found for the following prompts: How well can you respond to difficult questions from your students? (M = 7.83; SD = .988; *p* <.001); How well can you establish routines to keep activities running smoothly (M = 7.87; SD = 7.87; *p* <.001); and How well can you provide an alternative explanation or example when students are confused? (M = 7.81; SD = 1.079; *p* <.001), indicating confidence in the ability to accomplish these tasks.

Efficacy in Student Engagement

Initial analysis of the eight ESE means yielded two levels of response. Four prompts had mean scores less than 6.50 and four had mean scores ranging from 6.50-6.99. The highest efficacy score in this category related to convincing students they can do well in school work (M = 6.99; SD = 1.437). Of the three efficacy subcategories (ESE, EIP, and ECM) the lowest efficacy scores occurred in this subcategory (Total M = 51.87). The two lowest individual efficacy scores, assisting families in helping students do well in school and getting through to the most difficult students, were both in this category (M = 5.95; SD = 1.941 and M = 5.99; SD = 1.789). All t-values were significant at the p<.001 confidence level in a comparison of the sample mean (M = 51.87; SD = 10.263) to the hypothetical mean (M = 40). These data are provided in Table 11.

Table 11

Teacher Efficacy in Student Engagement by Secondary Science Teachers

Teacher Efficacy Prompt	M	SD	*t*-value
1. How much can you do to get through to the most difficult students?	5.99	1.789	7.225***
2. How much can you do to help your students think critically?	6.95	1.399	18.208***
4. How much can you do to motivate students who show low interest in school work?	6.09	1.772	8.028***
6. How much can you do to get students to believe they can do well in school work?	6.99	1.437	18.038***
9. How much can you do to help your students value learning?	6.82	1.514	15.654***
12. How much can you do to foster student creativity?	6.95	1.579	16.121***
14. How much can you do to improve the understanding of a student who is failing?	6.45	1.666	11.253***
22. How much can you do to assist families in helping their children do well in school?	5.95	1.941	6.363***
Subcategory Total	51.87	10.263	15.126***

*** p <.001 Individual Strategy Scale: 1 = Nothing 9 = A Great Deal N = 190
Subcategory R = 8-72

Efficacy in Instructional Practice

Initial analysis of EIP yielded two response levels. Five prompts had mean scores below 7.50. Three prompts had scores greater than 7.50. The prompt regarding implementation of alternative strategies in the classroom was the only prompt in EIP to fall below seven (M = 6.96; SD = 1.515). The highest individual prompt in this category was gauging student comprehension of the material taught (M = 7.87; SD = 1.139). The overall sub-score average for EIP was M = 7.47, nearly a full point higher on the scale (1-9) than the ESE score. The efficacy scores for the EIP category were greater than those for ESE and ECM, yielding the highest subcategory mean (M= 59.03) of the three subcategories (ESE, EIP, ECM), indicating respondents had higher efficacy for instructional practice than classroom management and student engagement. All t-values were significant at the p<.001 confidence level. These data are provided in Table 12.

Table 12

Teacher Efficacy in Instructional Practice by Secondary Science Teachers

Teacher Efficacy Prompt	M	SD	*t*-value
7. How well can you respond to difficult questions from your students?	7.83	0.988	37.212***
10. How much can you do to gauge student comprehension of what you have taught?	7.87	1.139	28.268***
11. How well can you craft good questions for your students?	7.41	1.187	26.369***
17. How much can you do to adjust your lessons to the proper level for individual students?	7.07	1.564	17.210***
18. How well can you use a variety of assessment strategies?	7.49	1.489	21.846***
20. How well can you provide an alternative explanation or example when students are confused?	7.81	1.579	34.082***
23. How well can you implement alternative strategies in your class?	6.96	1.515	16.911***
24. How well can you provide appropriate challenges for very capable students?	7.33	1.251	24.393***
Subcategory Total	59.03	7.951	31.297***

****p* <.001 Individual Efficacy Scale: 1 = Nothing 9 = A Great Deal N = 190
Subcategory R = 8-72

Efficacy in Classroom Management

Initial analysis of ECM yielded two response levels. Five prompts had mean scores less than 7.40. Three prompts had mean scores greater than 7.40. Only one prompt yielded a response lower than seven, regarding calming students who are disruptive or noisy (M = 6.95; SD = 1.661). The ECM category yielded the highest individual efficacy score, for making expectations clear about student behavior (M = 8.12; SD = 1.167). The overall sub-category average for ECM was M = 7.41. The ECM score was 0.06 points lower than EIP. ECM had a greater subcategory mean than ESE (M = 58.96). All t-values were significant at the p<.001 confidence level.

Table 13

Teacher Efficacy in Classroom Management by Secondary Science Teachers

Teacher Efficacy Prompt	M	SD	*t*-value
3. How much can you do to control disruptive behavior?	7.23	1.684	17.301***
5. How much can you do to make your expectations clear about student behavior?	8.12	1.167	34.916***
8. How well can you establish routines to keep activities running smoothly?	7.87	1.304	28.713***
13. How much can you do to get children to follow classroom rules?	7.47	1.593	20.142***
15. How much can you do to calm a student who is disruptive or noisy?	6.95	1.661	15.280***
16. How well can you establish a classroom management system with groups of students?	7.38	1.550	20.037***
19. How much can you do to keep a few problem students from ruining an entire lesson?	7.21	1.730	16.625***
21. How well can you respond to defiant students?	7.04	1.608	16.556***
Subcategory Total c	58.96	10.399	23.842***

****p* <.001 Individual Strategy Scale: 1 = Nothing 9 = A Great N = 190 Subcategory R = 8-72

Teacher Efficacy Levels Based on Demographic Variables

This section examines the relationship between the selected demographic variables, total efficacy level, and the three efficacy sub-scores. The total efficacy level was obtained by summing each participant's responses to the 24 efficacy prompts to obtain a total efficacy score. Each prompt also belonged to one of the three subcategories: Efficacy in Student Engagement (ESE), Efficacy in Instructional Practice (EIP), and Efficacy in Classroom Management (ECM). The individual scores for prompts in each of these categories were summed to obtain a sub-score for that category. The total efficacy score and each of the scores (ESE, EIP, and ECM) were compared to the following demographic variables: school level (middle school vs. high school), total years of teaching experience, years of teaching science, science courses taught in 2011-2012, teaching an AP course, school SES level, size of student population, and number of students in a typical science course at the school.

An independent samples t-test was used to determine if significant differences existed in total efficacy (TE) level and each of the three sub-scores (ESE, EIP, and ECM) and school level (middle school or high school). No significant differences based on school level were found in total teacher efficacy levels or efficacy levels for the Efficacy in Instructional Practices and Efficacy in Classroom Management sub-scores. There were significant differences based on school level for the ESE subcategory. Middle school teachers ($M = 53.58$; $SD = 9.22$; $p<.05$) reported a higher level of efficacy than high school teachers ($M = 50.25$; $SD = 10.97$; $p<.05$). These data are provided in Table 14.

Table 14

Mean Differences in Total and Sub-score Efficacy Levels Based on School Level

	Middle School		High School		
Total and Sub-Scale Efficacy Scores	M	SD	M	SD	*t*
Total	173.16	23.32	166.63	27.45	1.66
Sub-Scale: Student Engagement	53.58	9.22	50.25	10.97	2.13*
Sub-Scale: Instructional Practice	59.53	7.50	58.52	8.38	.83
Sub-Scale: Classroom Management	60.05	9.21	57.87	11.34	1.37

*p <.05 n= 81 (Middle School) n= 89 (High School) Total Efficacy R = 24-216
Sub-Score R = 8-72

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the total efficacy level and each of the three subcategories (ESE, EIP and ECM) based on participants' total years of teaching experience. No significant differences were found among the participants' efficacy levels based on total years of teaching experience. These data are provided in Table 15.

Table 15

Mean Differences in Total and Sub-score Efficacy Levels Based on Total Years of Teaching Experience

	5 or fewer		6-10		11-15		16-20		21-25		26+		
Efficacy	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	*f*
Total	167.06	28.87	168.42	21.30	168.04	25.72	179.41	32.64	164.21	23.10	174.47	20.41	1.050
ESE	51.53	11.33	51.17	8.99	52.33	9.39	55.76	12.49	48.68	9.24	52.36	9.39	.914
EIP	58.49	8.17	57.88	7.21	57.38	8.03	61.82	9.73	56.79	8.48	61.53	6.23	1.832
ECM	57.04	11.57	59.38	8.60	58.33	10.04	61.82	12.88	58.74	8.25	60.58	9.80	.803

N = 190

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the total efficacy level and each of the three subcategories (ESE, EIP and ECM) based on participants' years of teaching science. No significant differences were found among the participants efficacy levels based on years of teaching science for the six categories. These data are provided in Table 16.

Table 16

Mean Differences in Total and Sub-score Efficacy Levels Based on Years of Teaching Science

	5 or less		6-10		11-15		16-20		21-25		26+		
Efficacy	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	*f*
Total	168.16	27.99	171.21	22.48	169.63	24.49	167.29	38.31	169.64	21.66	173.62	16.97	.217
ESE	52.20	10.94	52.21	9.51	51.96	10.09	50.07	13.54	52.50	8.15	51.34	9.52	.127
EIP	58.44	7.95	58.38	7.80	59.71	7.62	57.43	11.34	57.21	8.95	62.00	5.40	1.22
ECM	57.52	11.32	60.62	7.97	57.96	8.83	59.79	15.46	59.93	7.37	60.28	10.37	.552

N = 190

An independent samples t-test was used to determine if significant differences existed in total efficacy (TE) level and each of the three sub-scores (ESE, EIP, and ECM) based on whether an instructor taught an AP or pre-AP course in the preceding five years including the 2011-2012 school year by comparing the means from the two groups. No significant difference was found between middle school and high school science teachers for total efficacy, ESE, EIP, or ECM based on whether or not a teacher taught an AP or pre-AP course. These data are provided in Table 17.

Table 17

Mean Differences in Total and Sub-score Efficacy Levels Based on AP Instruction

	AP		No_AP		
Total and Sub-Scale Efficacy Scores	M	SD	M	SD	*t*
Total	170.08	21.00	169.80	26.85	.059
Sub-Scale: Student Engagement	51.47	8.27	51.98	10.76	-.262
Sub-Scale: Instructional Practice	58.94	8.12	59.05	7.94	-.072
Sub-Scale: Classroom Management	59.67	7.96	58.77	10.98	.458

n= 36 (AP) n= 135 (No AP) Total Efficacy R = 24-216 Sub-score R = 8-72

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the total efficacy level and each of the three subcategories (ESE, EIP and ECM) based on school SES level. No significant differences based on school SES were found in teacher efficacy level. These data are provided in Table 18.

Table 18

Mean Differences in Total and Sub-score Efficacy Levels Based on School SES

	35% or Less		36%-50%		51%-75%		76+%		
Total and Sub-Scale Efficacy	M	SD	M	SD	M	SD	M	SD	*f*
Total	179.56	13.427	166.86	24.232	170.82	25.304	169.63	169.88	.683
ESE	53.44	7.002	49.76	10.448	52.86	10.140	52.67	11.533	1.045
EIP	62.22	3.993	58.22	7.739	59.32	7.145	58.67	10.532	.724
ECM	63.89	6.547	58.88	9.109	58.64	11.000	58.30	12.642	.712

Total n = 9 ESE n = 50 EIP n = 76 ECM n = 27 Total Efficacy R = 24-216
Sub-Score R = 8-72

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the total efficacy level and each of the three sub-scores (ESE, EIP and ECM) based on school size using the parameters set by the WVSSAC for the 2011-2012 school year. No significant differences based on school size were found in the Efficacy in Student Engagement and Efficacy in Classroom Management sub-scores.

There were significant differences based on school size for total efficacy level and Efficacy in Instructional Practice. The lowest mean score for Total Efficacy was the AAA group (M = 165.43; SD = 25.911). The highest mean score for Total Efficacy was the A group (M = 180.00; SD = 20.667). The lowest mean score for EIP was the AAA group (M = 57.43; SD = 7.857). The highest mean score for EIP was the A group (M = 61.42; SD = 6.894). The EIP total mean was 59.14 (SD = 7.852). These data are provided in Table 19.

Table 19

Mean Differences in Total and Sub-score Efficacy Levels Based on School Size

	A		AA		AAA		
Total and Sub-scale Efficacy Scores	M	SD	M	SD	M	SD	*f*
Total	180.00	20.667	171.32	26.105	165.43	25.911	3.356*
Sub-scale: Student Engagement	55.85	8.172	52.22	9.774	50.27	11.078	2.963
Sub-scale: Instructional Practice	61.42	6.894	60.13	7.896	57.43	7.857	3.536*
Sub-scale: Classroom Management	62.73	7.341	58.97	11.075	57.73	10.504	2.256

N = 190 *p < .05 A n = 42 AA n = 43 AAA n = 40

A one-way analysis of variance (ANOVA) was used to determine if a significant difference existed in the total efficacy level and each of the three subcategories (ESE, EIP and ECM) based on the typical number of students in science classes at respondents' schools (20 or fewer students, 21-25 students, 26 + students). No relationships were found to be significant based on class size. These data are provided in Table 20.

Table 20

Mean Differences in Total and Sub-score Efficacy Levels Based on Class Size

	20 or fewer		21-25		26 +		
Total and Sub-Scale Efficacy	M	SD	M	SD	M	SD	*f*
Total	169.46	23.840	170.69	26.387	168.44	26.153	.117
Sub-scale: Student Engagement	51.65	8.519	51.90	11.490	52.00	9.008	.012
Sub-scale: Instructional Practice	59.05	7.457	58.87	8.064	59.35	8.289	.053
Sub-scale: Classroom Management	58.76	11.154	59.92	9.552	57.09	11.397	1.092

N = 190

Relationship between Efficacy Level and Constructivist Practice Use

In the second part of the survey participants were asked to indicate their level of use of 16 selected research based constructivist instructional practices on a scale of 1-5, with 1 = Never and 5 = Very Frequently. The individual scores were summed to provide the Total Level of Use of Constructivist Instructional Practices (TLCIP) score.

In the third part of the survey West Virginia science educators were asked to use a scale of 1-9 to indicate their level of efficacy for the given prompts, with 1 = Nothing and 9 = A Great Deal. The section contained 24 prompts. Each individual score was summed to provide a total efficacy score as well as the individual scores. The individual scores were also divided into subcategories with eight prompts in each of the three subcategories.

These eight scores were also summed to obtain a subcategory score for each of the three subcategories. This process yielded a total efficacy score and three subscores for Efficacy in Student Engagement (ESE), Efficacy in Instructional Practice (EIP) and Efficacy in Classroom Management (ECM).

The Total Level of Use of Constructivist Instructional Practices (TLCIP) score was compared with the total efficacy score (TE) and the three efficacy sub-scores (ESE, EIP, and ECM) using a Pearson Product-Moment Correlation Coefficient (r). The total efficacy score (TE) and each sub-score (ESE, EIP, and ECM) was also compared with each individual constructivist strategy using a Pearson Product-Moment Correlation Coefficient (r). These comparisons were used to determine if a significant relationship existed between the level of use for each constructivist instructional practice, the three subcategories of efficacy, and total efficacy. Relationships were described using Holcomb's (2006) scale of none to perfect where .00 = no relationship, .01-.24 = weak, .25-.49 = moderate, .50-.74 = moderately strong, .75-.99 = very strong, and 1.00 = perfect. Table 21 and Appendix H contain the Pearson r findings for each of these relationships.

The results of the Pearson r between the Total Level of Use of Constructivist Instructional Practices (TLCIP) score, total efficacy (TE) score, and each of the three sub-score totals (ESE, EIP, and ECM) are provided in Table 21. Correlation coefficients ranged from .281 - .523. The relationship between TLCIP CPI and TE level was moderate at .464 ($p<.01$). The relationship between TLCIP and ESE was highest at .523 ($p<.01$), or moderately strong. The relationship between TLCIP and EIP was moderate at .454 ($p<.01$). The relationship between TLCIP and ECM was lowest at .281 ($p<.01$), but still in the moderate range. These data are presented in Table 21.

Table 21

Pearson Product-Moment Correlations between Total Level of Use of Constructivist Practices, Total Efficacy, and Three Efficacy Sub-scores

Measure	TLCIP
TLCIP – Total Use Level	—
TE – Total Efficacy	.464**
ESE – Efficacy in Student Engagement	.523**
EIP – Efficacy in Instructional Practice	.454**
ECM – Efficacy in Classroom Management	.281**

**p <.01 (2-tailed) N = 190

The Pearson r correlations between the total efficacy score (TE) and each of the 16 individual constructivist instructional practices were also determined. All correlations between TE and the 16 constructivist instructional practices were found to be significant. Eleven relationships were significant at p<.001 and five were significant at the p<.01 level. The five relationships at the p<.01 level were weak according to Holcomb's scale (.01-.24) and the remaining 11 (p<.001) were moderate according to the scale (.25-.49). These data are presented in Appendix H.

The Pearson r correlations between the three sub-scores (ESE, EIP, and ECM) and the 16 constructivist instructional practices were also determined. Correlations between ESE and each of the 16 constructivist instructional practices resulted in three relationships significant at the p<.01 confidence level and 13 significant at the p<.001 level. Two of the relationships were weak according to Holcomb's (2006) scale (.01-.24) while the other 14 relationships were moderate according to the scale (.25-.49). The correlations between (EIP) and each of the 16 constructivist instructional practices resulted in three relationships significant at the $p<.05$ confidence level. One of the relationships was significant at the $p<.01$ confidence level and the other 12 were significant at the $p<.001$ confidence level. Four of the relationships (those at the $p<.05$ and $p<.01$ confidence levels) were weak according to Holcomb's (2006) scale (.01-.24) while the 12 relationships with significance at the $p<.001$ level were moderate according to the scale (.25-.49). The correlations between ECM and each of the 16 constructivist instructional practices resulted in one relationship significant at the $p<.05$ confidence level, five significant at the $p<.01$, level, and three significant at the $p<.001$ confidence level. Six of the relationships (those at the $p<.05$ and $p<.01$ confidence levels) were weak according to Holcomb's (2006) scale (.01-.24) whereas the other three relationships significant at the $p<.001$ confidence level were moderate according to the scale (.25-.49). These data are presented in Appendix H.

Findings from Follow-Up Interviews

Online survey respondents were given the opportunity to participate in a short follow-up telephone interview guided by five questions. Twenty-three individuals indicated their willingness to participate by providing contact information in the free response questions at the end of the survey. Fifteen of these 23 respondents were selected for the follow-up telephone interviews. These interviews were designed to clarify the quantitative survey results through emergent category analysis (Zhang & Wildemuth, 2009). The purpose of this section is to present the results of these follow-up interviews. The results for the analysis of each of the five phone interview questions are included. A chart summarizing participant responses is included in Appendix J.

Timing of Instructional Practice Use

Respondents provided a range of responses to this question. Five respondents indicated daily use of constructivist instructional practices, with two indicating at least weekly use. Five science teachers also indicated use of constructivist instructional practices as part of laboratory or post-lab activities. Two indicated using these practices as part of discussions (such as book discussions or current events discussions), and one indicated using it as part of lecture activities.

Two science teachers indicated using constructivist instructional practices as part of opening activities and one indicated using it for only reinforcement purposes. Four science teachers indicated use of constructivist practices as part of group work and four indicated its use as part of presentations. Two instructors utilize these practices as part of larger projects and three utilize them to help students make connections to other topics and the real world. One science teacher also indicated the use of guest speakers, whereas four individuals specifically indicated that they do not utilize guest speakers.

Nine science teachers indicated that field trips are not easily integrated into the science program at their school and are therefore not used. Three respondents listed field trips as part of their integration of constructivist instructional practices. Six science teachers responded that the use of role play was part of their constructivist practice implementation, while six also indicated that they do not use role play in the classroom. Three respondents stated that they take students outside the classroom to other parts of the campus for activities. Four instructors indicated that they reserve constructivist instructional classes for their advanced courses, including AP courses.

Several uses of constructivist practices were mentioned by only one respondent. These practices included use of constructivist practices to force students to explain and justify their work, use to improve student work ethic, use as part of technology integration, use to improve student writing, and use of constructivist practices to help students overcome changes in society and family difficulties. Another instructor indicated use of constructivist practices simply to provide variety for everyone involved.

Factors Influencing Instructional Practice Selection

Seven science teachers noted the importance of the CSOs in practice selection. Five science instructors discussed the importance of the student's background in the subject matter and noted that student prior knowledge/achievement influenced their selection of instructional practices. Four instructors also indicated that student strengths, needs, and/or reactions influenced practice selection.

Other responses obtained from three or fewer science teachers included: practice effectiveness influencing selection of practices (three teachers); the need for variety, past experiences and successes, the need for reinforcement, pacing guides and curriculum maps, use of PBL, time, and money (two teachers). One instructor indicated during the interview process that student interests, problem solving/critical thinking, AP course requirements, the internet, laboratory activities, material availability, sustainability of the practice, and student behavior influence selection of instructional practices.

Benefits of Constructivist Practices in the Science Classroom

The most common response for how the use of constructivist instructional practices benefited students in West Virginia science classrooms was that they helped build excitement and "wonder" in students, increasing motivation (six respondents). Six science teachers also responded that the hands-on practices and laboratory activities used in the classroom are helpful. Four teachers indicated that former students have contacted them and elaborated on activities from the course that benefited them later in life. Four respondents also indicated deepening student understanding and building a variety of student skills (leadership, use of tools, maintaining lab area, and group work) as benefits of constructivist instructional practice.

Two respondents indicated that adherence to the scientific method and experimental design benefit students and two indicated that practical knowledge and community need influence their selection of practices. Establishing a common language, preparing students for presentations, constructing meaning, applying knowledge, helping students retain knowledge longer, and large class size were each given once as benefits of constructivist instructional practices.

Aspects of Constructivist Practices that Promote Learning

The two most common aspects of constructivist instruction cited by instructors (cited five times each) as promoting student learning were establishment of routines and setting forth clear expectations. The next most common responses included the use of rubrics, providing visual/concrete examples of concepts that relate to students, and providing alternative assessments and products to reach different learning styles (four responses each). Providing students with the freedom to explore and control over their own learning was indicated by three science educators as promoting student learning.

Group work, laboratory activities, applying knowledge, and providing students with samples of expected products/work were also identified as examples of activities that promoted student learning by three respondents. Finally, the following constructivist practices were indicated as promoting student learning by one respondent: building confidence, allowing time to fully develop activities, creating equality among classes, shortening assessments, providing adaptation/options for students with special needs, providing opportunities for technology integration, and promoting high expectations.

Barriers to Implementation of New Instructional Practices

The two most commonly cited barriers to implementing new instructional practices were lack of time and student apathy (four responses each). Barriers cited by three respondents included lack of parental support, students facing difficult and/or dangerous situations at home, differing expectations among staff and/or staff support, money, students from low SES backgrounds, and lack of materials in school and/or in the home. Barriers cited by two respondents included lack of administrative support, students unreceptive to cross-curricular work, lack of technology in the school, parents/students not valuing education, inability to read on grade level, too many preps/overworked, and large class sizes. Fourteen instructional barriers were listed by respondents only once: negative parent attitude toward school, lack of infrastructure in old buildings, old equipment, students not having basic needs met before they come to school, student abuse of cell phones, learned helplessness, low math skills, inability to apply material, inexperience using graphing calculators, too much standardized testing, lack of technology in the home, anything that upsets students' routines, too little time for planning, and disrespect.

Instrument Reliability

The purpose of this section is to examine the reliability of the survey instrument. The instructional practices portion of the survey instrument and the teacher efficacy portion of the instrument were examined for internal consistency using Chronbach's alpha coefficient. It is important to determine internal consistency, or the degree to which the items in the instrument measure the same construct (Pallant, 2007). Pallant indicated that though the coefficient values are sensitive they should be above .7 for appropriate internal consistency.

The Cronbach's alpha based on the 16 constructivist instructional practices was .880. This value was greater than the necessary value of .7 according to Pallant (2007) indicating acceptable internal consistency of the instructional practices portion of the survey instrument. These data are provided in Table 22.

Table 22

Cronbach's Alpha Values for Individual Items and Total Constructivist Practice Implemented

Constructivist Practice	M	SD	α
1. Group students in order to divide a larger task and work together to complete.	3.61	.836	.874
2. Provide ideas related to a topic and form new connections and deeper understanding of topic.	3.93	.689	.874
3. Pool collective student knowledge in groups or class wide to share ideas and clarify understanding.	3.7	.753	.876
4. Provide students with examples and attributes of a word/topic which students utilize to form a definition.	3.59	.943	.874
5. Have students list as many items as possible related to a topic and group/regroup them by similarities.	2.94	.905	.877
6. Ask questions of students and lead students to ask questions of one another.	3.52	.946	.873
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate the results.	2.95	.948	.868
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	2.81	.801	.872
9. Have students list all important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	3.13	.825	.870
10. Identify a theme, essential question, or big idea and have students use supplemental material to explore topic.	3.52	.953	.878
11. Have students assume the roles of others and experience new perspectives to solve a problem.	2.63	.887	.877
12. Alternate roles with students to summarize, predict, and clarify passages.	2.73	.954	.871
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…	2.31	.829	.878
14. Require students to work together to solve a problem that mimics one found in the real world.	3.52	.904	.869
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	3.27	.829	.876
16. Require students to formulate and solve a problem with a focus on creating a concrete product.	3.31	.899	.868
Total Constructivist Practice Level	51.48	8.347	.880

N = 153

The Cronbach's alpha was calculated for the 24 efficacy prompts resulting in a value of α = .957. This value was greater than the necessary value of .7 according to Pallant (2007) indicating acceptable internal consistency of the individual efficacy prompts and total efficacy. These data are provided in Table 23.

Table 23

Cronbach's Alpha Values for Individual Efficacy Prompts and Total Efficacy

Efficacy Prompt	M	SD	α
1. How much can you do to get through to difficult students?	5.99	1.790	.957
2. How much can you do to help your students think critically?	6.95	1.420	.956
3. How much can you do to control disruptive behavior?	7.24	1.711	.956
4. How much can you do to motivate students with low interest?	6.09	1.795	.956
5. How much can you do to make behavior expectations clear?	8.16	1.165	.956
6. How much can you do to get students to believe they can do well?	6.97	1.460	.955
7. How well can you respond to difficult questions from students?	7.86	.970	.957
8. How well can you establish smooth routines for activities?	7.95	1.238	.956
9. How much can you do to help your students value learning?	6.78	1.535	.956
10. How much can you do to gauge student comprehension?	7.47	1.145	.956
11. How well can you craft good questions for your students?	7.41	1.192	.956
12. How much can you do to foster student creativity?	6.96	1.573	.956
13. How much can you do to get children to follow classroom rules?	7.50	1.591	.954
14. How much can you improve the understanding failing students?	6.43	1.638	.954
15. How much can you do to calm a disruptive/noisy student?	6.94	1.673	.954
16. How well can you establish a classroom management system?	7.42	1.572	.954
17. How much can you adjust your lessons for individual students?	7.10	1.552	.956
18. How well can you use a variety of assessment strategies?	7.55	1.432	.956
19. How much can you do to keep a few problem students from ruining an entire lesson?	7.22	1.731	.955
20. How well can you provide an alternative explanation or example when students are confused?	7.85	1.066	.956
21. How well can you respond to defiant students?	7.11	1.538	.955
22. How much can you do to assist families in helping their children do well in school?	5.96	1.953	.956
23. How well can you implement alternative strategies in your class?	6.95	1.530	.955
24. How well can you provide appropriate challenges for very capable students?	7.36	1.273	.956
Total Efficacy Score	171.24	25.606	.957

N= 152

The Cronbach's alpha was calculated for the three sub-scores of efficacy (ESE, EIP, and ECM). Cronbach's alpha for ESE was α = .903. Cronbach's alpha for EIP was α = .884. Cronbach's alpha was α = .940 for ECM. Each of these values was greater than the necessary value of .7 according to Pallant (2007) indicating acceptable internal consistency of the individual efficacy prompts and total efficacy. These data are provided in Table 24.

Table 24

Cronbach's Alpha Values for ESE, EIP, and ECM

Efficacy Prompts by Sub-Score	M	SD	α
Efficacy in Student Engagement			
1. How much can you do to get through to difficult students?	5.99	1.80	.895
2. How much can you do to help your students think critically?	6.94	1.411	.896
4. How much can you do to motivate students with low interest?	6.12	1.780	.887
6. How much can you do to get students to believe they can do well?	6.99	1.438	.883
9. How much can you do to help your students value learning?	6.81	1.534	.889
12. How much can you do to foster student creativity?	6.96	1.596	.894
14. How much can you improve the understanding failing students?	6.45	1.671	.882
22. How much can you do to assist families in helping their children do well in school?	5.94	1.973	.897
ESE Sub-Score Total (n = 8)	52.22	10.254	.903
Efficacy in Instructional Practices			
7. How well can you respond to difficult questions from students?	7.83	.985	.880
10. How much can you do to gauge student comprehension?	7.46	1.145	.864
11. How well can you craft good questions for your students?	7.41	1.194	.869
17. How much can you do to adjust your lessons to the proper level for individual students?	7.06	1.576	.868
18. How well can you use a variety of assessment strategies?	7.50	1.492	.869
20. How well can you provide an alternative explanation or example when students are confused?	7.82	1.078	.873
23. How well can you implement alternative strategies in your class?	6.96	1.508	.863
24. How well can you provide appropriate challenges for very capable students?	7.33	1.266	.870
EIP Sub-Score Total (n = 8)	59.36	7.710	.884
Efficacy in Classroom Management			
3. How much can you do to control disruptive behavior?	7.21	1.697	.933
5. How much can you do to make behavior expectations clear?	8.12	1.171	.944
8. How well can you establish smooth routines for activities?	7.85	1.316	.937
13. How much can you do to get children to follow classroom rules?	7.45	1.606	.926
15. How much can you do to calm a disruptive/noisy student?	6.94	1.668	.928
16. How well can you establish a classroom management system with groups of students?	7.38	1.568	.930
19. How much can you do to keep a few problem students from ruining an entire lesson?	7.18	1.748	.930
21. How well can you respond to defiant students?	7.07	1.555	.932
ECM Sub-Score Total (n = 8)	59.20	10.434	.940

ESE N = 163; EIP N = 165; ECM N = 164

Summary of Findings

The purpose of this chapter was to present data gathered for a study examining the level of use of constructivist instructional practices and teacher efficacy in West Virginia (WV) science classrooms. Respondents were asked to rate their level of use of selected instructional practices and level of efficacy. In addition follow-up interviews were conducted to clarify concepts and identify barriers.

In general WV science teachers described their level of use of constructivist instructional practices as frequent, with 10 of the 16 practices surveyed resulting in a level of use of 3.0 (Frequent use) or greater on a scale of 1-5. Results from a one sample t-test were found to be significant for each of the 16 individual practices as well as a total practice score obtained by summing the individual items ($p<.001$).

The level of use of constructivist instructional practices was analyzed via an independent samples t-test to determine if significant differences existed based on selected demographic variables. Overall, few significant differences were found based on demographic variables. Two individual practices were found to be different based on school level (middle school vs. high school). Two practices were also significant based on total years of teaching and one practice was significant based on years of teaching science. One individual practice was significantly different based on AP vs No-AP instruction. One individual practice was significant based on size of the student population and one individual practice was significant based on class size. No significant differences were found in the total level of use score for constructivist practices based on any of the demographic variables.

In general, WV science teacher's described their level of efficacy regarding teaching science as moderately high. Fourteen individual efficacy prompts had mean values of 7.0 or greater on a scale of 1-9. One-sample t-tests for each prompt, as well as a total efficacy score obtained by summing the prompts, and three sub-scores (Efficacy in Student Engagement – ESE, Efficacy in Instructional Practice - EIP, and Efficacy in Classroom Management – ECM) obtained by dividing the prompts into three groups of eight resulted in significance at the $p<.001$ level. Each individual prompt mean, the total efficacy mean, and each efficacy sub-score mean was significantly different from the mean for a hypothetical normal distribution.

The total efficacy score and the three efficacy sub-scores were also analyzed based on the selected demographic variables. One sub-score, ESE, was found to be significant for school level (middle vs. high school). No significant differences were found for total years of teaching, years of teaching science, teaching an AP course, school SES, or the number of students in the science classroom. The total efficacy score and EIP sub-score were found to be significant based on size of the student population.

The total efficacy (TE) score and each of the efficacy sub-scores (ESE, EIP, and ECM) was compared to the total level of use of constructivist instructional practice score using a Pearson Product-Moment Correlation Coefficient (r). Each relationship was significant at the $p<.01$ level. The relationship between the total level of use score and TE, EIP, and ECM were moderate and the relationship between the total level of use score and ESE was moderately strong (Holcomb, 2006). Relationships were also determined for each individual constructivist practice and the four efficacy scores (TE, ESE, EIP, and ECM). The relationship between TE and the practices resulted in significant relationships at the weak to moderate level. The relationships between ESE and EIP and the practices were significant and moderate. The relationships between ECM and the practices were mixed with nine significant relationships (three moderate and six weak).

The findings from the follow-up telephone interviews yielded additional data regarding level of use of constructivist instructional practices. Five of 15 respondents indicated using constructivist practices daily, though four reserved them for advanced classes. Dominant influences on practice selection included state CSOs, student strengths/weaknesses, time, and effectiveness. Benefits of constructivist practice utilization included building excitement, motivation, increasing skills, and deepening understanding. Setting clear expectations, routines, rubrics, examples, and alternative assessments were listed as promoters of practice success. However, few respondents indicated that field trips, guest speakers, and role playing were regularly utilized and 29 barriers to new practice implementation were identified.

Cronbach's alpha resulted in a desirable level of internal consistency and reliability for the constructivist instructional practices ($\alpha = .88$) and the efficacy portion of the instrument ($\alpha = .957$) with values greater than .7 (Pallant, 2007). Cronbach's α values for each of the individual constructivist practices and individual efficacy prompts also yielded acceptable internal consistency. Cronbach's α was calculated for each of the three efficacy sub-scores and also yielded acceptable internal consistency (ESE $\alpha = .903$, EIP $\alpha = .884$, and ECM $\alpha = .940$).

CHAPTER 5: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter reviews the purpose of the study, demographic data, and summarizes the methods and findings. The chapter ends by presenting the study conclusions, a discussion of implications, and recommendations for further study.

Purpose of the Study

The purpose of the study was to examine the level of use of selected research based constructivist instructional practices and level of teacher efficacy in middle school and high school science teachers in the state of West Virginia for the 2011-2012 school year. Both level of use of constructivist instructional practices and teacher efficacy were examined for differences based on selected demographic variables. In addition this study sought to determine if a relationship existed between level of use of constructivist instructional practices and teacher efficacy level. The following research questions were addressed:

1. What are West Virginia science teachers' levels of use of selected constructivist instructional practices in West Virginia science classrooms?
2. What are the differences, if any, in the level of use of constructivist instructional practices based on selected demographic variables (years of teaching, Advanced Placement course instruction, SES level, class size)?
3. What are West Virginia science teachers' levels of efficacy regarding teaching science in WV science classrooms?

4. What are the differences, if any, in West Virginia science teacher efficacy levels for teaching science based on selected demographic variables (years of teaching, Advanced Placement course instruction, SES level, class size)?
5. What is the relationship, if any, between teacher efficacy level for teaching science and the use of selected constructivist instructional practices in West Virginia science classrooms?

Population

The population for this study was any West Virginia middle or high school science teacher who taught at least one science course during the 2011-2012 school year. At the time of the study West Virginia had approximately 120 high schools and 156 middle schools with 1,898 science teachers instructing one or more science courses (WVDE, 2011). Science teachers from all of West Virginia's 55 counties were included in the survey.

Methods

This study was completed using a mixed-methods design. Primary data collection was quantitative utilizing a one shot cross-sectional design survey model via SurveyMonkey from one group of subjects at one point in time.

The survey instrument contained three sections: a demographics section, instructional practices, and teacher efficacy. The instructional practice section used a researcher developed five-point Likert scale with 16 selected constructivist instructional practices created by a review of the literature and validated by expert review. Respondents were asked to indicate the frequency of use of the constructivist instructional practices. The teacher efficacy section consisted of a researcher adapted (with permission) version of the *Teacher Self Efficacy Scale* from Ohio State University. Respondents were asked to indicate their level of efficacy for teaching science by responding to 24 prompts with a nine-point Likart scale. Finally respondents were given the opportunity to participate in a short follow up telephone survey through two open ended questions.

The instrument was distributed to middle school and high school science teachers in West Virginia's 55 counties via SurveyMonkey. The link was forwarded to the school principal to forward to instructors in their building teaching one or more science courses in the 2011-2012 school year. Survey responses were received from 201 science educators and analyzed to determine differences in level of practice use and efficacy level based on selected demographic variables.

Mean scores were calculated for the total level of use of constructivist instructional practices, total efficacy level, and three subcategories of efficacy. One sample t-tests were used to determine deviation of the means from the expected mean values of hypothetical normal distributions. Independent sample t-tests and one-way analysis of variance (ANOVA) were used to determine if the differences existed in level of constructivist practice implementation or efficacy level based on selected demographic variables. Pearson Product-Moment Correlation Coefficients (r) were determined between the level of use of the selected constructivist instructional practices and the total level of efficacy and the three subcategories.

Summary of Findings

The majority of respondents were high school (52.1%) general science teachers (51.6%). Thirty-seven respondents taught an AP or pre-AP course. The largest group of respondents had five or fewer years of total teaching (29.5%) and five or fewer years of teaching science (34.2%). Overall, respondents (58.5%) indicated large numbers of low SES students (more than 50% free and reduced lunch). Most respondents (85.8%) worked in AA or AAA schools and taught in classrooms with 21 or more students (80%).

One sample t-tests were performed comparing the mean of each of the 16 individual constructivist instructional practices and the total level of use of constructivist practices score to a hypothetical normal distribution resulting in significance for each at the $p<.001$ level. Practices were also analyzed based on selected demographic variables. Two of the practices resulted in significant differences for school level (middle school vs. high school) and total years of teaching experience. One practice was significant based on years of teaching science, teaching AP/pre-AP courses, school size, and class size. No significant differences were found based on SES level. No significant differences were found for the total efficacy score based on any of the selected demographic variables.

One sample t-tests were used to compare the sample mean for each individual prompt, the total efficacy score (TE) and three efficacy sub-scores (ESE, EIP, and ECM) to the mean from a hypothetical normal distribution. Each was significant at the $p<.001$ level. Teacher efficacy was examined with regard to the same demographic variables as instructional practices. For school level (middle vs. high school) only ESE yielded significance. No significant differences were found based on total years of teaching, years of teaching science, AP instruction, school SES level, or the number of students in the classroom. The relationships between school size, TE and EIP were significant.

A Pearson-Product Moment Correlation Coefficient (r) was performed comparing the total level of constructivist practice implementation score with TE, ESE, EIP, and ECM as well as between each constructivist practice and the four efficacy scores. All relationships ranged from moderate to strong (Holcomb, 2006). Moderate relationships included the relationships between level of use of the constructivist practices and TE, EIP, and ECM. The relationship between constructivist practice use and ESE was moderately strong. Each individual constructivist practice was compared to TE resulting in eight moderate and eight weak relationships. Each individual practice was compared to ESE resulting in 14 moderate and two weak relationships. Each individual practice was compared to EIP resulting in 12 moderate and four weak relationships. Each practice was compared to ECM resulting in six weak and three moderate relationships.

The findings from the follow-up telephone interviews yielded additional data regarding the level of use of constructivist instructional practices. Five of 15 respondents indicated using constructivist practices daily, though four reserved them for advanced courses. Dominant influences on practice selection included state CSOs, student strengths/weaknesses, time, and effectiveness. Benefits of using the practices included building excitement, motivation, increasing skills, and deepening understanding. Setting clear expectations, routines, rubrics, examples, and alternative assessments were listed as promoting success. Field trips, guest speakers, and role playing were not regularly utilized. Twenty-nine barriers for new practice implementation were identified.

Overall, acceptable internal consistency and reliability were found for each portion of the survey instrument (constructivist instructional practice portion $\alpha = .88$ and efficacy $\alpha = .957$). Cronbach's α values for each of the individual constructivist practices and individual efficacy prompts also yielded acceptable internal consistency. Cronbach's α for each of the three efficacy sub-scores (ESE $\alpha = .903$, EIP $\alpha = .884$, ECM $\alpha = .940$) also yielded acceptable internal consistency (Pallant, 2007).

Conclusions

Data collected as part of this study were sufficient to support the following conclusions:

Primary Research Questions

Levels of Use of Selected Constructivist Instructional Practices

Fourteen of the 16 constructivist practices and the total use score yielded a mean significantly different than that of a hypothetical normal distribution. Overall, West Virginia science teachers frequently used the selected constructivist instructional practices, with ten of the 16 practices used frequently.

Levels of Use Based on Demographic Data

Overall, few significant differences were found in the level of use of constructivist instructional practices based on the selected demographic variables for the individual and total use score. Only eight individual practices yielded significant differences for the demographic variables: two for school level, two for total years of teaching experience, one for years of teaching science, one for AP/Pre-AP instruction, one for school size, and one for average class size. Although there were significant differences in use level of constructivist instructional practices based on these six demographic variables, none of these differences were sufficient to conclude that there were differences in overall use based on the variables.

Teacher Efficacy Levels

Overall, West Virginia science teachers' indicated moderately high efficacy (7.12 on a 9 point scale) levels significantly different than the expected normal distribution (M = 5) for each of the individual efficacy prompts, each of the sub-scores of efficacy (ESE, EIP, and ECM), and the total efficacy score. Overall, West Virginia science educators believe that what they are doing makes a difference in the science classroom.

Teacher Efficacy Levels Based on Demographic Variables

Overall, few significant differences were found in total efficacy (TE) or the three sub-scores (ESE, EIP, ECM). Only three significant differences were found in efficacy level based on a demographic variable. TE and EIP were found to be significant at the $p<.05$ level based on school size. EIP was significantly higher in A schools. ESE was higher for middle school. Although there were significant differences in efficacy level based on these three demographic variables, none of these differences were sufficient to conclude that there were differences in overall efficacy level based on the variables.

Relationship between Efficacy Level and Constructivist Practice Use

Overall, the relationship between teacher efficacy and use of constructivist instructional practices in West Virginia science classrooms is moderate but significant.

The relationship between total level of constructivist practices implementation (TLCPI) and TE, the relationship between TLCPI and EIP, and the relationship between TLCPI and ECM were moderate. The relationship between TLCPI and ESE was moderately strong. When viewed individually the relationships between the constructivist practices and TE, ESE, EIP, and ECM were weak to moderate.

Interview Findings

Data collected as part of the follow-up telephone interviews in the study were used to support the conclusions for each of the interview questions below:

Timing of Instructional Practices Use

Overall, West Virginia science teachers participating in the survey frequently utilized constructivist practices as part of the following activities: laboratory work, group work, presentations, and for advanced courses. Five of 15 respondents utilized such practices daily. Field trips, guest speakers, and role playing were rarely utilized by respondents.

Factors Influencing Instructional Practice Selection

The two most dominant factors influencing selection of instructional practices for respondents were the state Content Standards and Objectives (CSOs) with 7 of 15 respondents indicating influence, followed by student background, achievement, or prior knowledge with 5 of 15 respondents indicating influence. Other factors included student strengths/needs/reactions and practice effectiveness.

Benefits of Constructivist Practices in the Science Classroom

Common benefits of constructivist instructional practices indicated by respondents included building student excitement, increasing motivation, building lab skills, and deepening understanding. Ten specific examples of activities instructors found to be particularly beneficial were provided. Four instructors cited evidence provided by former students of activities that benefited them in college or life.

Aspects of Constructivist Practices that Promote Learning

Overall, the two aspects of constructivist instruction most commonly cited by respondents as promoting learning were routines and clear expectations (5 of 15 respondents). Other important aspects of constructivist instruction cited by respondents included: providing visual/concrete examples of concepts, use of rubrics, and providing alternative products/assessments for students with different learning styles.

Barriers to Implementation of New Instructional Practices

Responses to this question were the most varied in the study. Twenty-nine different barriers were given, indicating that barriers may be situation specific. The two most common barriers given were lack of time and student apathy, followed by money, lack of materials at home/school, lack of parental support, difficulties/danger at home, differing expectations, and students from low SES backgrounds.

Instrument Reliability

All portions of the survey instrument exhibited acceptable levels of internal consistency. The individual and total level of use scores for the constructivist instructional practices each yielded alpha values greater than the necessary value of .7 (Pallant, 2007). The total efficacy and three efficacy sub-scores (ESE, EIP, and ECM) yielded alpha values greater than .7 as well.

Discussion and Implications

The findings of this study can be used by science teachers, administrators, and policy makers as they strive to make decisions regarding instructional practice at the classroom, school, and state/district levels. The data could inform practice selection, professional development, and help overcome barriers to implementing new practices. The following discussion and implications section is organized around the study research questions and ancillary findings.

Constructivist Practices: Level of Use

The one sample t-tests used to compare the level of use means of each constructivist practice and the total level of use means for comparable hypothetical normal distribution revealed significant differences for the total use score and 14 of the 16 practices. Ten of the significant sample means were larger than the expected mean in the hypothetical normal distribution. Six of these sample means were greater than 3.5. These results indicate that the science teachers participating in the survey used the practices in a manner greater than expected in a normal population. This above average constructivist practice implementation is beneficial for West Virginia's science students and provides the type of education researchers indicate meets student needs today (Barak & Shakhman, 2007). These results also suggest that West Virginia's science educators are already using the practices necessary for successful implementation of Next

Generation Science Standards (Next Generation Science Standards, 2011). These findings are important for the implementation of the Next Generation Science Standards since a greater than expected use of constructivist practices will allow educators to more readily engage students with the new standards. Educators will already be familiar with the practices necessary to implement the standards, easing the transition for everyone. Four of the 16 practices produced means significantly lower than those expected in a normal distribution. These practices were: allowing students to choose a topic or problem, look for causes, supports, and effects (M = 2.77), having students assume the roles of others and experience new perspective to solve a problem (M = 2.65), alternating roles with students to summarize, predict, and clarify (M = 2.73), and requiring students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…. (M = 2.26).

Additional information on use of these strategies was provided in the follow up telephone interviews. Respondents cited role playing and exploration outside the classroom/field trips as difficult to implement and/or not part of their curriculum. Barriers to implementation of such practices, including lack of time, lack of money, and lack of support in the home, were also revealed in the telephone interviews. These barriers could prevent instructors from implementing certain constructivist instructional practices particularly those that are time intensive or create extra expenses. Administrators, teacher preparation programs, and professional development programs must follow research-based recommendations and provide science teachers with the materials and support necessary to increase the use of these constructivist practices (NSTA Position Statement: Leadership in Science Education, 2011).

Demographic Variables and Level of Use

Two of the individual practices, having students assume the role of others to experience new perspectives and solve problems, and alternating roles with students to summarize, predict, and clarify passages, resulted in significant differences based on school level. Middle school teachers reported higher levels of use for both practices. No significant differences were found for the total level of use score or the remaining 14 individual practices. The lack of significant findings may indicate a need for more research in this area. The small sample size and relatively homogeneous sample of West Virginia science educators may have also affected the results. A study with a larger, more diverse population may result in a different outcome.

Surprisingly, no significant differences were found for the total use score based on years of teaching or years of experience teaching science. Overall these results agreed with the research indicating that years of experience was not a significant contributor to student achievement. Multiple researchers found that years of experience did not significantly influence student learning (Giglio, 2010; Jones, 2006). Again, more research is needed in this area as numerous studies also found that years of experience significantly influenced student achievement (Clotfelter, Ladd, and Vigdor, 2007; Haimson, 2011; Holley, 2008; McCue, 2011; Rockoff, 2004). A larger sample population of more diverse educators could result in a different outcome. Overall the results do not indicate whether an instructor had taught an AP or pre-AP is a factor in determining use levels for constructivist practices. However, since only 37 respondents indicated they taught an AP or pre-AP course a different outcome may result with a larger sample population.

No significant differences were found in the level of use of the 16 individual constructivist practices and total use score based on school SES level. These results were some of the most surprising of the survey. Numerous authors indicated that poverty negatively influences student achievement (Holliday, 2011; Jensen, 2009; Payne, 2005). Because achievement is influenced by selection of instructional strategies, constructivist strategies have been recommended for use with low SES populations (Costello, Hollifield, & Stinnett, 1996; Keller, 2005; McKinney, Flenner, Frazier, & Abrams, 2006). However, West Virginia's student population is relatively homogeneous with a larger subpopulation of low SES students across the board. Additional research with a more diverse student population is needed for this variable.

No significant difference was found for the total level of use score based on the size of the student population or the number of students in science class. These findings were likewise surprising because many studies indicate that students benefit from smaller class size (Achi, 2011; Flowers, 2010; Picus, 2000). However, other authors (Whitehurst & Chingos, 2011) found that the effects of class size were minimal and benefits do not outweigh the financial burden. The findings from the current study agree with the latter research indicating that class size does not significantly influence practice selection, and consequently student achievement. Because research on class size, like years of experience, is mixed, more studies with larger educator populations may be beneficial.

Levels of Teacher Efficacy for Teaching Science

The 24 efficacy prompts, the total efficacy score (TE), the sub-score for Efficacy in Student Engagement (ESE), the sub-score for Efficacy in Instructional Practice (EIP), and the sub-score for Efficacy in Classroom Management (ECM) were found to be significantly different than the hypothetical normal distribution for the applicable comparison group. Mean scores for each of the groups were well above the hypothetical mean for their group suggesting that the science teachers responding to the survey had moderately high efficacy levels with regard to teaching science. These results are also very encouraging for science education in West Virginia. If West Virginia science educators already have moderately high efficacy levels, they believe that what they are doing in the classroom promotes learning (Woolfolk, 2000). Teacher efficacy is positively correlated with instructional practice implementation (Tschannen-Moran, Hoy, & Hoy, 1998) so West Virginia science teachers are willing to implement new methods to meet student needs. Sustained professional development which builds on this willingness with regard to constructivist practices should be implemented to further increase usage of constructivist instructional practices.

A willing educator population, provided with appropriate research-based professional development, materials, time, and funding can implement programming to meet the needs of the Next Generation Science Standards and improve test scores and student performance. However, materials, time, and money were all listed by follow-up survey respondents as barriers to implementation of constructivist practices. Administrators and policy makers at the local, state, and county levels must take this into consideration as they plan programs and allocate funding. Teacher efficacy is shaped by experiences in the classroom, particularly early in an educator’s career (Woolfolk Hoy, 2000). If educators are constantly undermined by these barriers or new practices fail as a result of them, educator efficacy may be negatively affected resulting in future unwillingness to try new practices.

The lowest overall efficacy sub-score was found for the ESE subcategory. The lowest individually scoring prompts also occurred in this category: assisting families in helping students do well in school and getting through to the most difficult students. EIP yielded the largest overall subcategory total. The highest individual prompt in this category (gauging student comprehension of material taught) had a mean of 7.87. Only one prompt yielded a response lower than 7.0 (calming students who are disruptive or noisy).

These results provide further information regarding West Virginia science teachers' levels of efficacy. West Virginia science teachers had the highest level of efficacy with regard to Efficacy in Instructional Practice (EIP), followed by Efficacy in Classroom Management (ECM), and Efficacy in Student Engagement (ESE). The fact that Efficacy in Instructional Practice yielded the highest efficacy score of the three subcategories is also encouraging for West Virginia Science educators. These findings agree with Albion's (1999) findings that teacher beliefs are important in practice selection, particularly choosing new practices for new situations (such as the Next Generation Science Standards).

ECM was a very close second behind EIP in efficacy level. This finding coincides with the literature, since Woolfolk (2000) listed classroom management as one of the factors efficacy is closely associated with in the classroom. These findings were also corroborated in the follow-up telephone interviews as many of the factors contributing to the success of constructivist instructional practices identified by respondents related to classroom management (setting forth clear expectations, establishing routines, etc….).

The finding that ESE was a distant third was also corroborated in the follow-up telephone interviews. Interviewees reported difficulties with student apathy, lack of motivation, and lack of support as barriers to implementation of new practices. Other respondents related that the lack of engagement they encounter in the classroom is a result of the students' home life. One interview respondent stated, "It has become the norm that kids are not going to do this…I don't give a lot of homework because the kids are living in these situations where they cannot concentrate. There are things that go on at home that are really a problem."

Demographic Variables and Level of Teacher Efficacy

Few significant differences in teacher efficacy based on school level were found for TE, EIP, or ECM. A significant difference was found for ESE based on this variable, with middle school teachers reporting higher levels of efficacy than high school teachers. These results suggest that middle school teachers have a higher belief in their ability to engage students than high school teachers. Since the structure of organizations effects teacher efficacy (Protheroe, 2008; Woolfolk Hoy, 2000) the team-oriented culture of middle schools may be more conducive to higher ESE.

No significant differences were found for TE, ESE, EIP, and ECM based on total years of teaching or years of experience teaching science. These findings correspond to the research indicating that efficacy is formed during the early years of teaching

(Woolfolk Hoy, 2000). The results agree with this research because, if a relatively stable efficacy concept forms in the early years of teaching, few differences would be found over time. Research specifically measuring changes in efficacy in the initial years of teaching may reveal a different outcome, as opposed to this study which grouped years one through five together. These results also have broader applications for administrators, policy makers, and teacher educators as they design training and support programs for new teachers. Appropriate professional development for new educators is crucial for developing high levels of efficacy, which will influence the educator's work in the classroom and student achievement throughout their career.

No significant difference was found in TE, ESE, EIP, and ECM based on whether or not participants taught an AP or pre-AP course in the preceding five years. This finding agrees with the previous findings for teaching an AP course, which indicated no significant differences for level of use of constructivist instructional practices based on this variable. However, just as with level of use of constructivist instructional practice the small sample size for AP instruction (37 instructors) may have limited the outcome. The need for more research in AP teacher efficacy is evident.

No significant differences in TE, ESE, EIP, or ECM efficacy levels were found based on school SES level. These results are encouraging for West Virginia's low SES students since the science teachers participating in the survey held moderately high efficacy levels regardless of school SES level. These findings indicate that West Virginia's high proportion of low SES students benefit from science educators who believe that what they do in the classroom makes a difference in student achievement. These findings are important because teachers with high efficacy are more likely to implement new programming (Protheroe, 2008; Tschannen-Moran, Hoy, & Hoy, 1998) necessary to reach low SES students (Costello, Hollifeld, & Stinnett, 1996; Keller, 2005; McKinney, Flenner, Frazier, & Abrams, 2006). Other studies suggest that teacher efficacy mitigates the effects of low SES (Tschannen-Moran, Hoy, & Hoy, 1998).

No significant differences in ESE and ECM were found based on the size of the student population. Significant differences in efficacy levels based on school size were found for TE and EIP. The lowest means for TE and EIP were reported by the AAA group and the highest mean was reported by the A group, suggesting the instructors in small schools possessed higher total efficacy and efficacy in instructional practice. When efficacy level was examined at the classroom level, however, smaller classrooms did not follow the pattern of smaller schools. No significant difference was found for TE, ESE, EIP, or ECM efficacy levels based on the number of students in science classes. The mixed results of school/classroom size variables indicate a need for more research.

Relationship between Teacher Efficacy and Use of Constructivist Practices

These results of the Pearson Product Moment Correlation Coefficient (r) between the total level of use of constructivist instructional practices and each of the four efficacy scores (total efficacy, efficacy in student engagement, efficacy in instructional practice, and efficacy in classroom management) indicate that the relationship between West Virginia science teacher's level of efficacy and implementation of the selected constructivist instructional practices is moderate overall. These findings agree with the previous efficacy findings given the moderately high teacher efficacy scores (22 of the 24 efficacy prompts resulted in significant means greater than 6 on a 9 point scale).

Teachers with higher efficacy are more willing to implement new instructional practices (Tshannen-Moran, Hoy, & Hoy, 1998). The authors broke this down further by indicating that efficacy affects teacher behavior, effort, and aspiration. West Virginia science teachers are therefore more likely to implement new constructivist practices as corroborated by 10 of the 16 individual constructivist practices resulting in means significantly higher than that which was expected in a normal distribution (M = 3 on a five point scale).

However, six constructivist instructional practices did not result in significant differences or resulted in significantly lower means, so there is still room for improvement. Work must be done through policy and professional development that will allow West Virginia science teachers to improve implementation of these six practices and overcome the barriers previously discussed in implementing them. Appropriate programming to further increase efficacy would also be beneficial since efficacy is context specific (Bandura, 1997; Tchannen-Moran, Hoy, & Hoy, 1998). Context specific factors related to the remaining six constructivist practices should be further researched and addressed to improve implementation level and consequently student learning.

The results from the current study indicate that appropriate training and professional development would be helpful in increasing all levels of efficacy, particularly that of student engagement. A moderate correlation was found between level of constructivist practice implementation and TE, EIP, and ECM. However, the relationship between level of constructivist practice implementation and ESE was moderately strong. The moderately strong relationship between ESE and level of constructivist practice implementation is of particular interest because science educators responding to the survey indicated the lowest subcategory total score in ESE, yet the strongest level of relationship existed between ESE and level of implementation of constructivist practice. With limited funding for professional development, targeted programming for efficacy in student engagement has the potential to make the greatest gain in teacher efficacy, constructivist practice implementation, and, consequently, student achievement.

Despite findings of high efficacy with regard to teaching science using constructivist instructional practices, the level of use of these practices was still moderate overall. Again, this discrepancy could result from many of the barriers identified in the follow-up interviews. Science teachers may feel very confident in their ability to make a difference teaching science using such practices but lack the time and money to do so. With support to overcome these and other barriers, science the relationship between efficacy level and level of use of constructivist instructional practices may prove to be stronger.

Instrument Reliability

Acceptable reliability and internal consistency were found for both the constructivist instructional practices portion of the instrument and the teacher efficacy portion of the instrument. All Chronbach's α values for the individual and total constructivist practices were greater than the accepted value of .7 (Pallant, 2007) with no value less than .86. All Chronbach's α values were greater than the accepted value for teacher efficacy as well, with no values less than .95. These values indicate that the instruments are useful in gathering information for their respective purposes. They would be useful instruments in further research on the topic, such as research in subject areas outside of the sciences.

Recommendations for Further Research

This study investigated the level of use of selected constructivist instructional practices, level of teacher efficacy, if these constructs varied by selected demographic variables, and the relationship between level of use of constructivist instructional practices and teacher efficacy (total efficacy and three efficacy sub-scores). The study also sought to examine emergent trends from the initial survey findings through the use of a qualitative follow-up telephone interview. Based on the study findings, the following recommendations for further research are provided:

1. This study focused on science educators in the state of West Virginia. Expanding the study to other states would vary demographics and provide a useful comparison, since West Virginia student demographics differ greatly from other populations, particularly in urban areas.
2. This study focused on science educators and constructivist instructional practices, however, these practices are useful across the curriculum, not just in science. Expanding the study to include other subject areas would provide a useful comparison between subjects.
3. Likewise, this study focused on science educators and efficacy, but teacher efficacy could influence practice selection and implementation in any subject area. Expanding the study to include other subject areas would provide a comparison for efficacy levels across subjects.

4. Study respondents provided the greatest variety of responses about barriers to implementation of instructional practices in the follow-up interview questions. Further qualitative and/or quantitative work regarding barriers to increasing the use of constructivist instructional practices is necessary to clarify the relationship between barriers and perceived barriers to the implementation of constructivist instructional practices.
5. This study was conducted at one time (2011-2012 school year) for instructors teaching one or more science courses in that time frame. However, teacher efficacy is a construct that can change over time, so a longitudinal study following a cohort of science educators over multiple years would clarify the relationship between years of experience and teacher efficacy level.
6. This study focused only on classroom teachers. There are many more individuals necessary to the effectiveness of a school. A survey of administrator efficacy level and teacher efficacy level in relation to level of implementation of new practices could provide a clearer picture of school-wide efficacy and practice.
7. This study focused on efficacy and instructional practice implementation, which is only part of the challenge in increasing student achievement. A study of instructor efficacy level and student achievement level could provide educators and researchers with valuable information on the relationship between educator efficacy and achievement.
8. This study focused on the level of implementation of selected instructional practices, not assessment of those practices. A study seeking to find the

relationship, if any, between constructivist practice implementation and type of assessment would also yield valuable information for educators in the classroom.

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APPENDICES

Appendix A: Instrument

A Survey of Science Teacher Efficacy and Instructional Practice in WV Secondary Schools

You are invited to participate in a research project entitled *A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms* designed to analyze the relationship, if any, between teacher efficacy and instructional practice. The study is being conducted by Dr. Ronald B. Childress and Amanda Knapp from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). This research is being conducted as part of the dissertation for Amanda Knapp.

This survey is comprised of questions referring to level of use of instructional practices from the literature, level of efficacy, and basic demographics. Your replies will be confidential.

There are no known risks involved with this study. Participation is completely voluntary and there will be no penalty or loss of benefits if you choose to not participate in this research study or to withdraw. If you choose not to participate or withdraw simply close/exit the window. You may choose to not answer any question by simply leaving it blank. You may move forward or back within the survey and no questions are required. Once you complete the survey you can delete your browsing history for added confidentiality.

Completing the on-line survey indicates your consent for use of the answers you supply. By completing this survey you are also confirming that you are 18 years of age or older. If you have any questions about the study or in the event of a research related injury, you may contact Dr. Childress at xxx.xxx.xxxx, or Amanda Knapp at xxx.xxx.xxxx (via email at xxxxxx@xxxxxx.xxx.xx.xx).

If you have any questions concerning your rights as a research participant you may contact the Marshall University Office of Research Integrity at (304) 696-4303.

Please print this page for your records.

Survey Link: XXXXXX

Amanda K. Knapp

West Virginia Science Teacher Level of Constructivist Instructional Practice Survey (WVSTCIP)

Demographics Page I- Please indicate the choice that best describes your current teaching situation.

1. Are you teaching one or more science classes at the middle/junior high or high school level in the 2011-2012 school year?

_____ Yes _____No

Demographics Page II - (Continued if respondents answer yes above. If respondent answers no he/she will be taken to the end of the survey).

1. Which of the following best describes the school level at which you teach the majority of your science classes?

☐ Middle/Junior High

☐ High School

☐ Both

2. Counting the 2011-2012 school year, how many total years of teaching experience do you have?

☐ 5 or less

☐ 6-10

☐ 11-15

☐ 16-20

☐ 21-25

☐ 26+

3. Counting the 2011-2012 school year, how many total years of teaching science do you have?

☐ 5 or less

- 6-10
- 11-15
- 16-20
- 21-25
- 26+

4. Please indicate the science course(s) you are teaching in 2011-2012. Check all that apply.

- General Science
- Chemistry
- Biological Science
- Environmental Science or Earth Science
- Physical Science
- Physics

Other (please specify)

5. Counting the 2011-2012 school year, have you taught an Advanced Placement (AP) course (high school) or Pre-AP course (middle/junior high school) in the last 5 years?

- Yes
- No

6. Which of the following best reflects the percent of children eligible for free and reduced lunch in your school in the current school year?

- Less than 35%
- 36-50%

☐ 51-75%

☐ 76% or more

7. Which of the following best reflects the size of the student population in your school?

☐ 339 or less

☐ 340-618

☐ 619 or more

8. Which of the following best describes the number of students in a typical science class in your school?

☐ Fewer than 10

☐ 11-15

☐ 16-20

☐ 21-25

☐ 26 or more

Part II: Instructional Practices - The following is a list of instructional practices. Please indicate on the 5 point scale provided below the level that best reflects the extent to which you use each of the practices in teaching science.
<u>Scale:</u>

1=Never
2=Hardly Ever
3=Sometimes
4=Frequently
5=Very Frequently

1 = Never 2 = Hardly Ever 3 = Sometimes 4 = Frequently 5 = Very Frequently

1. Group students in order to divide a larger task and work together to complete it.	1	2	3	4	5

2. Provide ideas related to a topic and form new connections and deeper understanding of the topic.	1	2	3	4	5
3. Pool collective student knowledge in groups or class wide to share ideas and clarify understanding.	1	2	3	4	5
4. Provide students with examples and attributes of a word/topic which students utilize to form a definition.	1	2	3	4	5
5. Have students list as many items as possible related to a topic and group/regroup them by similarities.	1	2	3	4	5
6. Ask questions of students and lead students to ask questions of one another.	1	2	3	4	5
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate the result.	1	2	3	4	5
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	1	2	3	4	5
9. Have students list all important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	1	2	3	4	5
10. Identify a theme, essential question, or big idea and have students use supplemental material to explore the topic.	1	2	3	4	5
11. Have students assume the roles of others and experience new perspectives to solve a problem.	1	2	3	4	5
12. Alternate roles with students to summarize, predict, and clarify passages.	1	2	3	4	5
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc…	1	2	3	4	5
14. Require students to work together to solve a problem that mimics one found in the real world	1	2	3	4	5
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	1	2	3	4	5
16. Require students to formulate and solve a problem with a focus on creating a concrete product.	1	2	3	4	5

Part III: Teacher Efficacy -The following is a list of questions about teaching science. Using the scale provided, please indicate the extent to which you believe you can accomplish each of these tasks in your science classroom. The scale is as follows:
1 = Nothing
9 = A Great Deal

	1 = Nothing								9 = A Great Deal
1. How much can you do to get through to the most difficult students?	1	2	3	4	5	6	7	8	9
2. How much can you do to help your students think critically?	1	2	3	4	5	6	7	8	9
3. How much can you do to control disruptive behavior?	1	2	3	4	5	6	7	8	9
4. How much can you do to motivate students who show low interest in school work?	1	2	3	4	5	6	7	8	9
5. How much can you do to make your expectations clear about student behavior?	1	2	3	4	5	6	7	8	9
6. How much can you do to get students to believe they can do well in school work?	1	2	3	4	5	6	7	8	9
7. How well can you respond to difficult questions from your students?	1	2	3	4	5	6	7	8	9
8. How well can you establish routines to keep activities running smoothly?	1	2	3	4	5	6	7	8	9
9. How much can you do to help your students value learning?	1	2	3	4	5	6	7	8	9
10. How much can you do to gauge student comprehension of what you have taught?	1	2	3	4	5	6	7	8	9
11. How well can you craft good questions for your students?	1	2	3	4	5	6	7	8	9
12. How much can you do to foster student creativity?	1	2	3	4	5	6	7	8	9
13. How much can you do to get children to follow classroom rules?	1	2	3	4	5	6	7	8	9
14. How much can you do to improve the understanding of a student who is failing?	1	2	3	4	5	6	7	8	9

15. How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5	6	7	8	9
16. How well can you establish a classroom management system with groups of students?	1	2	3	4	5	6	7	8	9
17. How much can you do to adjust your lessons to the proper level for individual students?	1	2	3	4	5	6	7	8	9
18. How well can you use a variety of assessment strategies?	1	2	3	4	5	6	7	8	9
19. How much can you do to keep a few problem students from ruining an entire lesson?	1	2	3	4	5	6	7	8	9
20. How well can you provide an alternative explanation or example when students are confused?	1	2	3	4	5	6	7	8	9
21. How well can you respond to defiant students?	1	2	3	4	5	6	7	8	9
22. How much can you do to assist families in helping their children do well in school?	1	2	3	4	5	6	7	8	9
23. How well can you implement alternative strategies in your class?	1	2	3	4	5	6	7	8	9
24. How well can you provide appropriate challenges for very capable students?	1	2	3	4	5	6	7	8	9

Part IV: Telephone Survey - If you are willing to participating in a short telephone interview regarding the survey please enter your e-mail address and phone number in the spaces below. Thank you.

E-mail Address ______________________________

Phone Number: ______________________________

Appendix B: Permission E-mails

E-mail 1: Permission to Use Instrument

July 14, 2011 9:42 AM

You are welcome to use the TSES in your dissertation research.

Anita

Anita Woolfolk Hoy, Professor

Educational Psychology & Philosophy

School of Educational Policy and Leadership

The Ohio State University

Columbus, OH 43210

phone: 614-488-5064

fax: 614-292-7900

e-mail anitahoy@mac.com

http://www.coe.ohio-state.edu/ahoy

E-mail 2: Permission to use E-mail File

RE: FW: Request for Permission to Distribute Surveys

Date: 10:34 AM 4/23/12

To: aknapp@access.k12.wv.us

From: Donna Jones

Ms. Knapp,

Unfortunately, we are unable to utilize our listserv for your survey**. I am attaching file of all principal emails within the state. Whatever you distribute should be sent from your access account. Due to the way the access server operates, you will only be able to send 50 emails at one time.**

If I may be of further assistance, please feel free to contact me.

-----Original Message-----

From: aknapp@access.k12.wv.us [mailto:aknapp@access.k12.wv.us]

Sent: Tuesday, April 17, 2012 9:46 AM

To: Donna Jones

Subject: Re: FW: Request for Permission to Distribute Surveys

Appendix C: Phone Interview Questions

1. When do you utilize constructivist instructional practices in your science classroom activities? (Examples will be provided if needed: opening a unit, culminating activity, attention-getter, etc…)
2. What factors influence your selection of instructional practices in the science classroom?
3. How have the constructivist instructional practices you implemented benefited students in your science classroom? Describe specific examples if applicable.
4. What aspects of constructivist instruction do you believe promote student learning?
5. What barriers (if any) do you encounter when implementing new instructional practices?

Appendix D: Principal Initial Contact and Reminder E-mails

To: WV Middle, Junior, and High School Principals (on e-mail list)

From: Date:

Dear Secondary School Administrator,

This is a request to distribute an electronic survey to the science teachers in your building. Middle, junior, and high school science teachers are being invited to participate in a state-wide confidential research survey. The title of the study is ***A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms.***

I am writing to request your assistance in completing this study. Within the week you will receive another e-mail containing the link to the electronic survey via SurveyMonkey. Please forward the e-mail containing the survey link to teachers in your building instructing at least one science course during the 2011 – 2012 school year. Forwarding the survey link indicates your consent for the teachers in your building to participate in the survey. If you do not wish for the science teachers in your building to participate in the study simply do not forward them the link.

The survey is being conducted as part of my doctoral program requirements for Marshall University. The information provided will assist in determining if a relationship exists between teacher efficacy level and instructional practice implementation. It will help science instructors make informed decisions and has the potential to assist administrators in planning professional development.

The online questionnaire will take approximately fifteen (15) minutes to complete. Participation is completely voluntary. Individual teachers and schools will not be identified. Data will be reported in aggregate. Teachers will also be provided with an opportunity to volunteer to participate in a short telephone follow-up interview.

If you have questions, you may contact me at 304-458-1817 or through e-mail at the address above. If you have questions concerning the rights of teachers participating in this research process, you may contact the Marshall University Office of Research Integrity at (304) 696-4303. Dr. Ron Childress, principal investigator for this study, may be reached at rchildress@marshall.edu , phone 304-746-1904.

Thank you in advance for your assistance with this survey and for your continued support of research in science education. I look forward to sharing the study results with you.

Amanda K. Knapp

Principal Reminder E-mail

Dear Middle/Junior or High School Principal:

Earlier this month your science teachers were invited to participate in a confidential research survey entitled **A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms.** As the survey collection window draws to a close this is a reminder to forward the survey link below to all instructors in your building teaching one or more science courses during the 2011-2012 school year if you have not done so already. If you have already forwarded the link to your teachers thank you for your support of research in science education.

If you have questions, you may contact me at 304.458.1817 or through e-mail at aknapp@access.k12.wv.us. If you have questions concerning the rights of teachers participating in this research process, you may contact the Marshall University Office of Research Integrity at (304) 696-4303. Dr. Ron Childress, principal investigator for this study, may be reached at rchildress@marshall.edu or by phone at 304-746-1904.

Thank you in advance for your assistance with this survey and for your continued support of research in science education.

Survey Link: XXXXX

Amanda K. Knapp

Co-Principal Investigator

Appendix E: IRB Stamped Consents (Online and Verbal)

Knapp 2012: A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms

Confidential Online Survey Consent

[redacted]

Marshall University IRB
Approved on: 05/04/12
Expires on: 05/04/13
Study number: 327087

(Included on Page 1 of the Instrument)

You are invited to participate in a research project entitled *A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms* designed to analyze the relationship, if any, between teacher efficacy and instructional practice. The study is being conducted by Dr. Ronald B. Childress and Amanda Knapp from Marshall University and has been approved by the Marshall University Institutional Review Board (IRB). This research is being conducted as part of the dissertation for Amanda Knapp. This survey is comprised of questions referring to level of use of instructional practices from the literature, level of efficacy, and basic demographics. Your replies will be confidential.

There are no known risks involved with this study. Participation is completely voluntary and there will be no penalty or loss of benefits if you choose to not participate in this research study or to withdraw. If you choose not to participate or withdraw simply close/exit the window. You may choose to not answer any question by simply leaving it blank. You may move forward or back within the survey and no questions are required. Once you complete the survey you can delete your browsing history for added confidentiality.

Completing the on-line survey indicates your consent for use of the answers you supply. By completing this survey you are also confirming that you are 18 years of age or older. If you have any questions about the study or in the event of a research related injury, you may contact Dr. Childress at 305.746.1904, or Amanda Knapp at 304.458.1817(via email at aknapp@access.k12.wv.us). If you have any questions concerning your rights as a research participant you may contact the Marshall University Office of Research Integrity at (304) 696-4303. Please print this page for your records.

Survey Link: XXXXXX
Amanda K. Knapp
Co-Principal Investigator
Chemistry/Physics Teacher
Buffalo High School

Consent to Participate in Research – Verbal Presentation

[redacted]

Marshall University IRB
Approved on: 05/04/12
Expires on: 05/04/13
Study number: 327087

Hello, my name is Amanda Knapp. I am a chemistry and physics teacher at Buffalo High school and Marshall University graduate student. You have been chosen to be in a study about the relationship between science teacher efficacy and level of constructivist instructional practice implementation in West Virginia science classrooms. You were chosen randomly from a pool of initial survey respondents who submitted contact information. This study involves research. The purpose of this research study is to determine the relationship, if any, between teacher efficacy level and level of constructivist instructional practice implementation. This will take 10 minutes of your time. If you choose to be in the study, I will ask a question and you will be expected to answer based on your experiences teaching science in West Virginia.

There are no foreseeable risks or benefits to you for participating in this study. There is no cost or payment to you. If you have questions while taking part, please stop me and ask. Your answers will remain confidential and no names or identifying information will be used.

If you have questions about this research study you may call me at 304.458.1817 and I will answer your questions. You should also contact Dr. Ronald B. Childress at 304.746.1904 in the event of a research related injury. If you feel as if you were not treated well during this study, or have questions concerning your rights as a research participant call the Marshall University Office of Research Integrity (ORI) at (304) 696-4303.

Your participation in this research is voluntary, and you will not be penalized or lose benefits if you refuse to participate or decide to stop. May I continue?

Appendix F: Initial IRB Approval Letter

MARSHALL UNIVERSITY®

w w w . m a r s h a l l . e d u

Office of Research Integrity
Institutional Review Board
401 11th St., Suite 1300
Huntington, WV 25701

FWA 00002704
IRB1 #00002205
IRB2 #00003206

May 4, 2012

Ronald Childress, EdD
MUGC Department of Education
RE: IRBNet ID# 327087-1

At: Marshall University Institutional Review Board #2 (Social/Behavioral)

Dear Dr. Childress:
Protocol Title: [327087-1] A Study of the Relationship between Science Teacher Efficacy and Level of Constructivist Instructional Practice Implementation in West Virginia Science Classrooms

Expiration Date: May 4, 2013
Site Location: MUGC
Submission Type: New Project APPROVED
Review Type: Expedited Review
In accordance with 45CFR46.110(a)(7), the above study and informed consent were granted Expedited approval today by the Marshall University Institutional Review Board #2 (Social/Behavioral) Chair for the period of 12 months. The approval will expire May 4, 2013. A continuing review request for this study must be submitted no later than 30 days prior to the expiration date.

This study is for student Amanda Knapp.
If you have any questions, please contact the Marshall University Institutional Review Board #2 (Social/Behavioral/Educational) Coordinator Michelle Woomer, B.A., M.S at (304) 696-4308 or woomer3@marshall.edu. Please include your study title and reference number in all correspondence with this office.

Appendix G: Sample Size Calculations

Sample Size Calculations: The co-investigator went to the WVSSAC website and counted the number of schools in each ranking (A, AA, AAA). Then using the number of teachers counted for the RESAs from earlier in the project, three schools of each ranking were counted and averaged. This allowed an estimate of the total number of science teachers in each ranking to be obtained. This number was then multiplied by the number of schools in the ranking category.

Average Number of Science Teachers in 42 A High Schools = 2.7 x 42 = 112

Buffalo = 3

Valley Fayette = 3 Average = 2.7

Hannan = 2

Average Number of Science Teachers in 43 AA High Schools = 5.7 x 43 = 243.7

Herbert Hoover = 6

Greenbrier West = 6 Average = 5.7

James Monroe = 5

Average Number of Science Teachers in 40 AAA High Schools = 12 x 40 = 480

Capitol = 10

Cabell Midland = 17 Average: 12

Hurricane = 9

Average number of high school science teachers rounded to nearest whole number = 836

Middle Schools =Total number of science instructors grades 6-12 from state = 1,898

Subtract average number of high school science teachers 1,898-836 = 1062

Small middle schools have 2-3 science instructors

Medium 5-6 science instructors

Large 9-11 science instructors

Appendix H: Pearson Product-Moment Correlations between Total Efficacy, ESE, EIP, & ECM and the Sixteen Constructivist Instructional Practices

Constructivist Practices	TE	ESE	EIP	ECM
1. Group students in order to divide a larger task and work together to complete it.	.379***	.411***	.339***	.268***
2. Provide ideas related to a topic and form new connections and deeper understanding of the topic.	.317***	.337***	.306***	.215**
3. Pool collective student knowledge in groups or class wide to share ideas and clarify understanding.	.309***	.320***	.263***	.245***
4. Provide students with examples and attributes of a word/topic which students utilize to form a definition.	.200**	.255***	.167*	.117
5. Have students list as many items as possible related to a topic and group/regroup them by similarities.	.180**	.218**	.182*	.092
6. Ask questions of students and lead students to ask questions of one another.	.388***	.392***	.341***	.309***
7. Provide students with a topic; they describe it, create analogies, identify conflicts, and evaluate the results.	.333***	.369***	.335***	.203**
8. Allow students to choose a topic or problem, look for causes, supports, and effects.	.355***	.383***	.379***	.207**
9. Have students list important facts, participants, actions, feelings, reasons, and alternative solutions to a problem.	.315***	.356***	.277***	.213**
10. Identify a theme, essential question, big idea and have students use supplemental material to explore the topic.	.278***	.341***	.289***	.129
11. Have students assume the roles of others and experience new perspectives to solve a problem.	.190**	.234**	.175*	.105
12. Alternate roles with students to summarize, predict, and clarify passages.	.239**	.289***	.207**	.148
13. Require students to explore situations outside the classroom in museums, gardens, with guest speakers, etc...	.257***	.290***	.311***	.110
14. Require students to work together to solve a problem that mimics one found in the real world.	.343***	.386***	.317***	.225**
15. Require students to work at their own pace through a cycle of questioning, seeking answers, and reflection.	.234**	.254**	.266***	.124
16. Require students to formulate and solve a problem with a focus on creating a concrete product.	.256***	.263***	.273***	.165*

* p <.05 **p <.01 ***p <.001 N = 168-176

Appendix I: Co-Investigator CV

Amanda Kristen Knapp

Address: 1377 Capehart Rd. Leon, WV 25123 Phone: (304) 458-1817

Academic Degrees

Master of Arts, 2006

Secondary Education
Marshall University

Bachelor of Arts/Bachelor of Science, 2003
Secondary Education/Biology

Summa Cum Laude/University Honors
Minors in French/Chemistry
Marshall University

Teacher Certification, 2006-2007
Chemistry/Physics
Wheeling Jesuit University

Current Licensure – WV Professional Teaching Certificate

Biological Sciences 9-Adult (Permanent)

General Science 5-Adult (Permanent)

Physics 9-Adult (Permanent)

Chemistry 9-Adult (Permanent)

Special Training/Certification

Biology Advanced Placement Training, 2004

Wheeling Jesuit University InStep Project-Based Learning, 2005

Chemistry Advanced Placement Training, 2006

Teacher Leader Institute (TLI), 2010

Chemistry Advanced Placement Training, 2011

Study Abroad, Summer 2001

Exeter College, Oxford University

Current Studies

Doctoral Student in Curriculum and Instruction
Area of Emphasis: Science Education

Professional Experience

Teacher, Putnam County Schools (2006 – Present)
Chemistry/Physics/Astronomy, Buffalo High School, Buffalo WV

Teacher, Jackson County Schools (2004-2006)
Biology/Earth Science/General Science/Chemistry, Ravenswood High School, Ravenswood WV

Substitute Teacher, Mason County Schools (Spring 2004)
Biology/Anatomy and Physiology/General Science
Hannan High School, Ashton WV

Grants

Education Alliance Mini Grant, 2008-2009

Funded $500 for Project Based Physics
Buffalo High School

Texas Instruments Calculator Grant
10 TI-Nspire Calculators
Buffalo High School

Donor's Choose.org 2008-2009 Funded $800 in Two Grants for T-I Nspire Calculators for Buffalo High School

Education Alliance Mini Grant, 2006-2007

Funded $1,000 for Light Analysis Equipment
Buffalo High School

Professional / Academic Memberships

Marshall University Society of Yeager Scholars
Omicron Delta Kappa Leadership Honorary (ODK)
National Association of Professional Women (NAPW)

Leadership Activities

Buffalo High School Next Generation Learning Team

Instructor Marshall University Graduate College

EDF 619E, Educational Psychology Online, Fall 2010

Co-Instructor/Module Designer
Marshall University Graduate College
EDF 610 Trends and Issues in Education Fall 2008.

Supervising Teacher

Marshall University Student Teacher Spring 2008

Awards and Recognition

NAPW Woman of the Year

Buffalo High School Teacher of the Year, 2009

Who's Who Among America's Teachers

Certificate of Excellence – Educational Testing Services for PLT Exam Scores

Appendix J: Phone Interview Analysis

Question 1 When do you utilize constructivist instructional practices in your science classroom activities?	**Question 2** What factors influence your selection of instructional practices in the science classroom?	**Question 3** How have the constructivist instructional practices you implemented benefited students in your science classroom? List specific examples if applicable.	**Question 4** What aspects of constructivist instruction do you believe promote student learning?	**Question 5** What barriers, if any, do you encounter when implementing new instructional practices?
Used during lecture or discussion time, or post-lab discussions. "We talk about ideas that spring up." -Few field trips due to location and few guest speakers. -Assume roles when doing environmental discussions to look at all sides. Take a side they do not support. Students come up to board and re-teach, assuming role of teacher. Reach each other in own terms.	-Time and money – loss of time to sports, other activities. -Spending limitations, science products are expensive and consumable.	-It helps them understand more than just giving scientific information. -Common language helps -Evidence: calls and visits from beginning bio students experiencing success because of activities in class.	-Providing routines, one of biggest concerns with new program. -Providing visual examples, even if it is simple (fuzzy balls for cilia). -Grab examples from classroom. -Routine the biggest one	-"Barriers for me are the students who have maybe no significant person in their lives who are watching over them." -Safety issues at home or monetary issues with food and clothing. -"The kids don't have their basic needs met so when they come to school learning is not something they are thinking about." -"If a student is having major issues maybe a short meeting with all of the teachers."
-Used a lot in physics – reaching deeper understanding; ask them to tell me why; justify what they do. -I use it with the more advanced chemistry	-Student background; what is their background in other subjects and knowledge; interests and strengths; focus on problems solving and critical thinking; push	-Presentations to a panel, questioning and constructing leads to much deeper level of understanding. -Not everything is effective this way. -Explain using video	-Students have some freedom to explore and some control in the direction of their learning but not all control. -Helps with the confidence issue; don't throw them	-Students claim "other teachers don't make us do this" and "we don't have to work as hard in other classes." -Technology barriers -Financial barriers

concepts. -Making connections to other areas and making questions to pull information and get them to make connections. -Few field trips due to funding	them into that uncomfortable area. -A lot of PBL, but lack of confidence from students necessitates baby steps. -Chem I Atomic Theory Example: Timeline of evolution of atomic model with connections to history (WWII).	analysis with the correct terminology to a panel of other teachers and professors from state, etc… especially in physics because they are seniors and have to take it to the next level.	out on a limb; have rubric and go over it. -Show examples of the type of work you want. -When you make expectations clear they can be successful.	-Parents don't see the relevance – their negative attitude influences the kids. -Lack of planning for the future
-At least once a week, usually Tues-Thurs; rarely Friday and not Monday. -Something out of desks weekly -Divide into groups by topic and each gets subtopic. -Not just labs – present posters and other data -Few field trips – principal against it due to not making AYP. -Lack of funding, paying for buses.	-AP Bio: has required labs so that is not negotiable. Also have a pacing guide have to follow. -No "canned labs" with other classes. -It is anything that might reinforce learning; a lot of reinforcement.	-It helps students get to know each other and apply knowledge they have learned already. -Don't have some skills at all, like measuring and dissection; "I get upper level kids who cannot read a ruler; have never used a hand tool – it's like teaching shop" -They are getting a lot of clean up skills – I don't clean up after them. -"The goal of lab – they want to see the end result so they pay attention even more." -Some classes misbehave - "It is stressful"	-Making things clear and keeping routines. -Applying the knowledge -If labs don't work they have to find out why. -There are a lot of things I could do if I had the technology.	-It is hard to reach some students who don't excel in the classroom; students who cannot read in 10th grade. -They still excel in lab; they spend time outside and using tools; if you give them a chance they can share what they know. -Having four different preps. -Funding -Building -Class size -Old equipment -Cell phones -Overworked -Too many classes to get ready for
-Everyday -Pooling ideas is common	-Probably the effectiveness with the students more than	"I would like to believe some of the things I try have been very beneficial."	-Routine and Rubrics -Eliminating things – especially with seniors	-They may not be getting a lot of help at home. -"I think the biggest

-Many outside trips and guest speakers -Community resources are important – a couple visitors a month -Learning from other teachers -Implementing role playing – kids hate it but get so much from it	anything.	-Have students do an experimental design with a question posed by instructor (start with scaffolding and take things away as they learn). -"They absolutely struggle and hate it in the beginning but at the end of the year they don't want to do regular labs."	who invent ways to do the minimum amount of work. -Take time to develop the activity so you don't hear "I didn't realize you wanted this." -Let them make the rubric and set the expectations. -I teach honors and regular classes and I don't want my general classes to think they are not getting the same thing.	problem is apathy. They just plain don't care. So many are ok with just passing. " -"I don't give a lot of extra credit because they don't do it even if they need it." -"Even if you give the test back and give them a chance to redo it- it's like no thanks."
-"We are concentrating on oral communication and work ethic as part of their grade." -"It is a societal thing….we were taught these things at home and now they are not and we are trying to take up the slack so to speak…ethics and communication." -They cannot communicate. -Visit to a college campus to expose them… a lot are low SES. -"Exposure is the key, let them see feel do and experience."	-CSOs; we have to cover them. -Internet -Get them into lab as much as possible. -Just use the text for reference and homework. -"Need to be learning and relearning".	-Labs are the most beneficial. -Hands-on 2-3 times a week -"We share labs and sign up with other teachers. If I can, I go outside and get them out and moving."	-Examples of good and bad lab reports -Rubrics with RAFT – roll, audience, format, topic and it gives them choices. -Lower functioning kids really excel – posters PowerPoint, game shows, etc… -Learning styles inventory. -"They can lean on each other and help each other learn. "	-Problems at home. -Assign different roles -Ask three then ask me rule -Low SES students lack exposure -"Show them how the world is and that they don't have to stay in the situation they are in… this learned helplessness. I want them to explore… some never do mature… you cannot turn your back on some of them."

-"I use them all the way through. I have found that variety is the key. You can't do the same thing every day." -"If you don't switch gears you lose them" -Team field trips but not individual class trips -No role play at current middle school job but did at high school for environmental issues.	-"What has worked in the past and the internet" -Search each CSO and compare current activities to what other teachers are using and see what fits better. -"I want to do something different"	-Example: Gummy bears in distilled, tap, and salt water. -Momentum with toy cars and clay. -"I try to find things that follow the scientific method" -Let students correct themselves -Gum drop molecules -Yeast balloons -Mousetrap catapults	-Routine... daily question with emphasis on writing, planner, then it varies… activity, reading, writing,… then we wrap up. -Moved to short little tests of 20 questions or so rather than large tests.	-Few barriers -Some have problems with math. -May have problems getting materials – provide for them. -Work on writing abstracts with language arts department -They cannot apply what they learned. -Cannot type things in calculator or graph -Not antagonize the other teachers.
-Honors Chemistry – Book discussion – "I throw things out and we take it from there." -No field trips due to subject matter limitations -"We go outside of the classroom for a role play of electron configurations because there is not enough room."	-"Primarily it is based on my years of experience and finding out what has worked and what has not worked. The prior knowledge is very limited….I know they have had stuff like naming compounds but they forgot it."	-"I have gotten feedback specifically from students who have gone on and taken chemistry in college… students said it is exactly what my professor is doing and I can do it. I am constantly looking for new labs and new approaches and stuff like that for covering the material."	-"Getting students directly involved in what they are doing. Encouraging them to help each other but definitely having clear expectations…. this is the way we do it here."	-Not being open to being cross curricular … "they have to read and critique an article from ChemMatters and they will fuss about this is not English class and why do I have to write. I mark grammar and spelling errors." -Little parent resistance
-"To deepen my students' understanding of a concept by providing relationships	-"I determine what my students' needs are, how easy it is to get their attention and keep it, how	-"My two goals when employing constructivist instruction is to achieve deeper understanding and	-"I just try my best to hit everyone up with something that relates to them. Sometimes it is like	-Attempt at change away from block scheduling that upset the status quo. -"The status quo is

to build on." -Example: Gas laws writing from weather perspective. -It moves info from short term to long term memory. -Sharing of prior knowledge from what works for each group of students in the past -Assign internet based searches – bonus points for a good discovery -Webquests	well do they retain information that I simply deliver, do they need a stronger connection to a topic or not?... I have to consider how much time we have to complete the remaining CSOs."	longer retention time." -Example: Type 2 nomenclature with different forms of iron. -"By providing useful analytic thinking of the happenstance in chemistry and physics we begin to see students getting intrigued by the wonder of nature and matter. This makes retention time longer than taking notes from an overhead"	pulling teeth but I try not to give up" -Keep on schedule -"Sometimes an evolutionary change is needed for some kids to catch on. Sometimes a revolutionary change is needed…"	comfortable for many and when you ask for change, that you clearly see will help students, you begin to see barriers all over the place." -Need for spaced practice for complex concepts.
-Twice a week – "I do problem based learning. It is hard to do field trips and things because of the red tape, money, and buses. I do not role play or do guest speakers."	-"I went to TLI for problem based learning so that is what I do."	-"I think it gets them more involved and excited. The interest level is not usually there for most of them" -Example: DNA gel electrophoresis (guest presenters).	-"I give a rubric before we do a lab or anything to make it clear what we need to do. They don't always have to do the same thing to get a product that is acceptable."	-"Mainly time. Trying to get through all of the CSOs because it takes time to do things. Money to do things is hard." -Administration desire for order in classroom -Research disputes this – explains need for collaboration.
-"I try to do it everyday. I usually have several units that I do it with. Usually it is toward the physics and earth science side. Not with chemistry. I don't want to give them the	-"I try to do a variety of things. If it does not work one way I will change it because of how they react. Some students just want it straight out. I will switch it up."	-"I have had kids take a role I did not know they would. Sometimes they will be the leader when you think they will be the follower." -Example: guys vs. girls rocket cars -"They don't have to ask you	-"You definitely need a routine, especially with 7th graders. They cannot handle it if you don't do the same thing. I like to switch it up…but they cannot handle it. It is best for the kids even though I	-"I think it is me…and trying to get them to understand. The administration is all for it, but the kids will say they don't want to do it and it is crazy." -Student motivation

opportunity to make a mess or hurt one another" -"Most of them are group projects. I give them ideas or sometimes I just let them run with it. I want to see what they can do." -Few trips -Role play – writing and RAFT with genetics		everything." -"I do have to monitor students getting upset. But for the most part they take their own role and go with it. That is the best part."	hate it but they thrive on it."	-Few family problems, if so give an alternate assignment. -Apathy -Too much standardized testing -Lack of time
-"Usually at the beginning of the class. We usually start off in cooperative learning groups and see how it impacts society… we brainstorm, ask why, then start getting into the basics… what we need to know and do in the project." -“We go outside every now and then but not on trips” -“Funding is the biggest issue and we don’t want to pull them away from other studies”. -Rarely role play -Make movies	-CSOs -Curriculum map -"I try to assess student prior knowledge and how we can tie that in on the curriculum we need to know to build on it."	-"We try to do things that they can use on a day to day basis. Mostly helping the community. If we want to explain force and motion maybe we will all go bowling. We go play ball to do simple machines to relate it to something they already know. Then we tie in the formula and do that but keep it hands on."	-Reading comprehension may not be good – listen to it instead -Multiple modalities – movies, PowerPoint -Presentations and papers -Connect to the real world -Use phone as a learning tool as long as it does not get out of hand -Apps: math, direction, sun/earth rotation, stars, mosquitoes	-Students with economic hardships -Students on their own -Students without computers at home so no assignments for homework -Lack of computers in the classroom – have to share mobile lab -Lack of materials -"You just have to treat each group of kids differently. We like the hands on activities."
-"I would use it as	-Cost: "You cannot ask	-"I do think it helps to make	-"I would say the hands-on	-"That’s the great question.

reinforcement. I would not start with it." -Labs -Projects -Group work -Kids busy outside of class -Fewer problems with trips at high school – now whole team has to go -Fitting in speakers is hard – must fit team -No role playing	kids and spending it out of your pocket… that's a big issue... we have to buy paper…" -Effectiveness -Available materials	the concrete connections and they retain information better. We do a lot of projects where they have to build things and we do a lot of that." -"The parents were telling me the kids were driving them crazy with it… they were engaged even outside of class… It was big though!"	activities and it is more relatable to them. Not just vocabulary out of the book. There is more interest in it."	Some have nothing. I have tried to provide all of the materials and not require anything outside. You have some kids go above and beyond but the ones that don't value education ... We have a lot of apathy."
-"Mostly with AP biology, especially since the curriculum is changing. That is primarily the main class I do. Students do pool knowledge. There is a degree of change to do out of school things. We have an 8 hour day now so they are reluctant to approve trips and speakers." - No role playing.	-"Mostly student achievement. I start with lecture and if they don't grasp it I supplement with other practices."	-"I think the main thing is since I teach upper level kids, preparing them for college. Based on what they tell me when they come back in terms of format and information."	-"In terms of making expectations clear and as high as possible."	-"The main thing is the time constraints in terms of covering CSOs. Making sure that while you implement new practices you still have to cover a multitude of CSOS. You just don't have time to cover everything. Reaching students is not usually a problem since it is upper level but reaching families, I don't have a lot of trouble with that the few times I have had to do it"
-Daily -Short lab → real world problem → discussion -Projects to end unit and	-Student behavior -State standards -Few field trips – instructed not to take them	-Motivation -"The students usually come in without good feelings about science."	-"It really gives them a purpose. They understand why they are doing this, why they are in a science	-Planning – "I want to have everything planned out and I want to know what I am doing and there are always

to assess	until after Westest -Only outside if working toward objectives. -Strict regulations -Some role playing with roles chosen by students	-Hands on activities as encouragement, assist with less exciting topics -Helps reach different learning styles, rather than just listening to lectures. -See, feel, smell -"They seem to have a lot of fun. I tell them that is why I teach science."	class and why it applies to them. -Projects used to overcome lack of caring; increase interest; show them you do care and they are easier to reach.	unforeseen issues." -Lack of family support - "It has become the norm that kids are not going to do this. I don't give a lot of homework because the kids are living in these situations where they cannot concentrate. There are things that go on at home that are really a problem." -Lack of respect
-Use of an opening activity -Electricity example – give common electrical parts and they have to light up a bulb with two types of circuits -Students explain verbally to teacher -Field trips difficult due to 45 minute periods -Used to go outside but also difficult due to 45 minute periods -Field trips difficult due to paper work and large numbers of kids -Rarely role play, mostly modeling how to use equipment in lab situations	- How well activity meets curriculum -It must be a practice that can be maintained consistently throughout year. -Suit needs of students -Appropriate to level of student -Help students master a standard. -Must actually work.	-Example: Adult came up and related remembering hottest part of flame -Bending glass tubing -Group work -Example: Earth science grouping arrangements -Necessary because of large class sizes (32) and teacher cannot be everywhere.	-"Especially with high school students they need to know up front this is what I can do and what I cannot do discipline wise." -Consistency is a "big deal" -Learning style inventory -"Understanding how each student absorbs information."	-"The only barrier to a new instructional practice would be trying to start it after the beginning of a year after you have already established a routine and then if you would not stay consistent with it." -Student resistance is not "the first thing" -Never had a problem financially "I consider our school very lucky no matter who is in charge. I have been to so many conferences and heard that this is not the case." -Class size might be a problem.