ANALYSIS OF ENVIRONMENTAL AND GENERAL SCIENCE EFFICACY AMONG INSTRUCTORS WITH CONTRASTING CLASS ETHNICITY DISTRIBUTIONS: A FOUR DIMENSIONAL ASSESSMENT

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This work is dedicate to my girls (Beth, Ryan, and Randi) and all who rise in the face of a challenge, persevering to the end through faith in God and undying pursuit….*FOR UNTO WHOMSOEVER MUCH IS GIVEN, OF HIM SHALL BE MUCH REQUIRED…LUKE 12:48.*

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Table of Contents

List of Tables

LIST OF FIGURES

FIGURES **PAGE**

NOMENCLATURE

ANOVA	Analysis of Variance
CED	Class Ethnicity Distribution
CM	Classroom Management
EEd	Environmental Education
EEEBI	Environmental Education Efficacy Belief Instrument
EE	Environmental Efficacy
EGSTEA	Environmental and General Science Teacher Efficacy Assessment
GSE	General Science Efficacy
HS	High School
Mid	Middle School
PTE	Personal Teacher Efficacy
OE	Outcome Expectancy
OSTES	Ohio State Teacher Efficacy Scale
SE	Student Engagement
STEBI	Science Teaching Efficacy Beliefs Instrument
10Yrs (+)	Greater than ten years teaching experience
10Yrs (-)	Less than ten years teaching experience

CHAPTER I

INTRODUCTION

Since 1939, the social significance and increasing importance of science has been recognized as a vital component within school curriculum (Blair & Goodson, 1939) providing knowledge of the living world and physical forces that perpetually drive its viability (Barber, 1915). The National Science Education Standards (NSES) (NRC, 1996) were established to guide the promotion of a scientifically literate society. The NSES demand a standard of quality in science education that provides all students with an opportunity to learn science (NRC, 1996).

The promotion of environmental education (EEd) and environmental literacy as a component of general science education should be characteristic of an effective science educator. Environmental education empowers individuals to understand and act on environmental issues (Stables & Bishop, 2001), thus preparing all individuals to be environmentally literate, drawing from ecological concerns through consideration of environmental impacts and the implications thereof for human life and sustainability (Stables & Bishop, 2001).

To make informed decisions all Americans will require an adequate environmental science (ES) knowledge base. This knowledge base affects views on how we manage critical environmental resources such as air, water, and our National Parks and forests (NRC, 1996). Although ES has become interdisciplinary in its curricular approaches and is being implemented within varying disciplines (Middlestadt et al., 1999; Sasse, 1997), examination of efficacy as it pertains to ES curriculum has been minimal. Novel studies on the need for better methods to prepare teachers to implement ES curriculum have been previously described (Moseley et al., 2002; Sia, 1992).

In science education, teacher beliefs are congruent with their mode of instruction (Brickhouse, 1989). Strong teaching efficacy results in more stringent planning and organization (Allinder, 1994), while weak teaching efficacy has been shown to substantially lower student achievement levels (King et al., 2001). The supposition that teacher efficacy is a determinant of students' achievement, motivational levels, and their own self-efficacy beliefs has been challenged and confirmed (Tschannen-Moran & Hoy, 2001).

Accurate assessment of teachers' self-efficacy should cover their competence throughout a wide range of curricular subject matter, activities, and tasks performed in their classroom (Tschannen-Moran & Hoy, 2001). According to Tschannen-Moran and Hoy (1998), validated assessments of teacher efficacy must measure both personal competence as well as external constraints as related to teaching in order to achieve a concise assessment.

Ethnicity, perceived intelligence, and academic performance have been shown to influence teachers' expectations (Rodney et al., 1986). Basic typecasting often governs reactions that perpetuate events affecting how people act, judge, decide, and solve problems (Anderson et al., 1988). Even experienced teachers have been shown to differentiate according to ethnicity; this behavior conveys messages that have deleterious effects on student outcomes (Melnick & Raudenbusch, 1986).

The current situation involving science education in minority high schools is drastically incompatible with that of its non-minority counterparts (King et al., 2001). Longitudinal research provides evidence that many teachers in economically depressed minority schools believe their students are incapable of extracting higher order principles from scientific disciplines (Beane, 1988), so many teachers abandon higher order methodology. An effective science instructor should view all students as capable of interjecting useful contributions during science learning (NRC, 1996). Equity should pervade all aspects of science learning (NRC, 1996).

The late 1980s marked the onset of policy drawn towards the lack of diversity in the environmental movement (Taylor, 2005). In 1990, environmental justice activists targeted top environmental non-profit organizations regarding their lack of minority representation within their organizations (Taylor, 2005).

Studies have examined the differences in the level of minority versus non-minority involvement in environmental issues, assessing perceptions, attitudes, concerns, support level, knowledge, and environmental awareness (Taylor, 1989). Although some minority individuals have developed thriving careers in a wide range of environmental professions (Taylor, 2005), past studies trace a significantly lower level of environmental interest among minorities when compared to that of non-minorities (Taylor, 1989).

Considerable discussion has been generated concerning efforts to improve diversity within the scientific community (Wenzel, 2003). The Science Technology Equal Opportunities Act called for the National Science Foundation (NSF) to increase the contributions of minorities in scientific, professional, and technical careers; yet minorities remain woefully underrepresented within scientific fields (Nocera et al., 1996).

Successful instruction of minorities has proved to be the result of stringent classroom expectations and positive beliefs for students by their instructors (Ladson-Billings, 1994). Negative preconceptions from instructors based on racial and/or socioeconomic factors impair the process by which minority students are motivated and distort the way their achievements are shaped (Payne, 1994). Despite findings of ill prepared science teachers and decreasing achievement in minority schools, very little empirical data has probed and highlighted causal links related to minority student achievement in science (King et al., 2001).

Problem Statement

Currently, there is a diminutive amount of cross-sectional science teacher efficacy data available that concomitantly compares efficacy for environmental and general science curriculums among instructors with contrasting class ethnicity distributions (CED) (minority vs. non-minority).

Purpose of Research

The context and nature of self-efficacy beliefs provides a method upon which to explore science instructors' perceptions of their own competence, self beliefs, and beliefs concerning their students as a function of ethnicity (Pajares, 1996). Promotion of a more in depth knowledge of science teacher self-efficacy beliefs requires cross-sectional and longitudinal investigations (Pajares, 1996). Here, a bi-disciplinary four dimensional assessment is utilized to measure personal teacher efficacy (PTE), general teacher efficacy or outcome expectancy (OE), classroom management (CM), and student engagement (SE). This unique approach not only examines elements that effect teachers' personal beliefs, but also examines external factors that impede instructors' abilities to present classroom information adequately; providing a more concise assessment of science teacher efficacy. Additionally, instructors' willingness to, and utilization of, practical instruction to reinforce science learning is also assessed.

A modified research instrument that combines the Environmental Education Efficacy Beliefs Instrument (EEEBI) (Sia, 1992), the Science Teaching Efficacy Beliefs Instrument (STEBI) (Riggs & Enochs, 1990), and factors 2 & 3 from the Ohio State Teacher Efficacy Scale (OSTES) (Tschannen-Moran & Hoy, 2001) is employed to create a bi-disciplinary Environmental and General Science Teacher Efficacy Assessment (EGSTEA) (Appendix A). This provides for an empirical assessment that targets efficacy as a leading factor in the genesis of the minority student achievement gap in science. The findings presented here will drive future research determinations on the down-stream affects of science teacher efficacy on students' own self-efficacy, outcomes, and achievements.

The applicable benefits of this research are the provisions for the determination of efficacy as a key contributive factor within the pathway for substantive rationale underlying the lack of minority representation and success within the many disciplines of science. A firm sense of self-efficacy is required to adequately relay the general essentials needed for minority students to excel in science.

Research Questions

The following research questions were addressed to examine variations in mean level environmental and general science efficacy among instructors with contrasting CED (minority vs. non-minority):

a. Is there a significant difference in mean environmental and general science efficacy scores for instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE), do mean efficacy response scores differ for instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

b. Is there a significant difference in mean environmental and general science efficacy scores for instructors who differ in years teaching experience (greater vs. less than 10 years) and have contrasting class ethnicity distributions (minority vs. non-minority)?

c. Is there a significant difference in mean environmental and general science efficacy scores for high and middle school instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE) among instructors of high and middle school students, do mean efficacy response scores differ among instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

d. Does instructor gender (male vs. female) affect mean environmental and general science efficacy scores among instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE), do mean efficacy response scores differ among male and female instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

e. What are the attitudes among instructors on practical applications for environmental instruction? Do attitudes differ among male and female instructors? Do attitudes differ among instructors with greater than 10 years experience when compared to that of instructors with less than ten years experience? Is there a difference in attitudes when the aforementioned variables are examined among instructors with contrasting class ethnicity distributions (minority vs. non-minority)?

f. Do variations exist among science instructors' extent of, and willingness to, utilize practical environmental instruction when comparing instructors with contrasting class ethnicity distributions? Is there a difference among willingness to, and utilization of, outdoor classrooms when comparing male and females or when examining instructor years teaching experience?

Scope of Study

Research participants consisted of convenience samples from high and middle school science instructors employed within various school districts. A single stage sampling procedure was utilized. Forty science instructors participated as marked by submission of a completed research questionnaire.

Assumptions

It was assumed that research participants responded accurately and honestly. It was also assumed that research instruments were understood by all means practicable.

Limitations

A major limitation of this study is the difficulty in obtaining a causal conclusion from cross-sectional data. A causal-comparative analysis cannot pinpoint a definitive causal link between science teacher self-efficacy and the achievement of minorities in environmental and general science.

There are numerous variables other than science teacher self-efficacy that may impede minority success in science; these include: students own self-efficacy, socioeconomic factors, non-attainable academic resources, familial structure, etc. (Bandura, 1986; Pajares, 1996). However, the consistently low efficacy scores referenced herein for science instructors with high minority CED can be utilized to highlight science teacher efficacy as a critical point of concern as well as a crucial factor in tracing the genesis of the minority achievement gap in science. Low science teacher efficacy has been shown to substantially lower student outcomes and achievement levels (King et al., 2001; Ashton & Webb, 1986; Hoy, 2000).

Lastly, this study was limited in sample number as well as regionalized diversification, as only a convenience sample of high and middle school science instructors employed within various school districts was utilized. Results for instructors employed within different states and/or areas of gross economic depression may vary.

Definition of Terms

a. *Self-Efficacy* - The belief that one is capable of organizing and executing a required action to manage a specified task; the personal judgment of one's ability to reach a specified goal (Bandura, 1986).
b. *Class Ethnicity Distribution* - The relative demographics of an instructor's classroom as related to race (i.e. minority and non-minority). Class ethnicity distribution was determined as greater than 50% ethnicity majority.
c. *Minority students* – For the purpose of this study references students of Hispanic, Black, or American Indian racial composition.
d. *Non-minority students* - For the purpose of this study references only students of White racial composition.

Composition of Dissertation

This dissertation is composed of five chapters. Chapter one as presented is the introduction. Chapter two begins with a review of pivotal literature as related to EEd with considerations given to general science education. Additionally, key research findings are summarized on self-efficacy as related to general self-efficacy, teacher self-efficacy, science teacher self-efficacy, efficacy for environmental curriculum, and science efficacy for teachers with high minority CED; literature on science education and minorities is also summarized. Chapter three presents the methodology utilized to implement this study and Chapter four presents the subsequent results. The dissertation is completed with Chapter five, which consists of a discussion of the results, conclusions, and implications of this study.

Chapter II

Review of Literature

<u>Environmental Science Education</u>

Environmental education (EEd) may be defined through many existing declarations, frameworks, definitions, and models. These varying degrees in interpretation all meet to form a common standard for a broad discipline. Based on historic charters and declarations (The Tbilisi Declaration in 1978 and The Belgrade Charter in 1976), a definition for EEd may be deduced. The Belgrade Charter (UNESCO-UNEP, 1976) suggests that EEd may be interpreted as the development of environmental awareness and concern driven through knowledge of environmental problems to prompt action towards resolve. Interpreting goals set forth within the Tbilisi Declaration (UNESCO, 1978), EEd may be defined in three components: The fostering of awareness on all aspects of environmental problems (e.g. economic, social, political, ecological, etc.); the provisions for equal opportunities to learn and enhance skill towards stewardship; and lastly, the installation of an ES knowledge base adequate to affect change.

Stapp and Cox's (1974) definition of EEd, as based on their EEd Model's philosophy and concept, can be defined as the learning of concepts based on the 'spaceship earth philosophy' which focuses on the ecosystem, population, economics, technology, environmental decisions, and environmental ethics to develop motivational character that promotes the adoption of a lifestyle compatible with stewardship.

Hungford and Peyton's (1980) goals for curriculum development in EEd consists of four levels; ecological foundation, conceptual awareness, investigation and evaluation, and resolution. Within these curricula, they defined EEd as the process by which individuals learn to communicate and apply major ecological concepts (e.g. species, population, communities, ecosystems, biogeochemical cycles, and energy), to analyze environmental issues and identify principles of importance, predict ecological outcomes based on solutions to environmental problems, and utilize science as a resource for environmental investigation. At the conceptual awareness level, EEd should hone communication skills involving environmental matters, create awareness on human impact to the environment, create awareness on major environmental issues, provide alternative solutions to ecological problems, promote investigation, consider sociological aspects of ES, and promote stewardship. At the investigation and evaluation level, EEd should promote the process by which individuals learn to apply necessary skills needed to investigate primary and secondary environmental problems, analyze environmental issues according to ecological and cultural implications, provide alternative solutions, deduce implications of alternative solutions, and adapt to new science and information. Lastly, at the resolution goal level EEd should promote the process by which individuals are provided necessary skills to demonstrate an adequate level of environmental competence (i.e. skills for persuasion, consumerism, politics, and law), evaluate actions according to ecological and cultural implications, and provide resolves.

Iozzi and colleagues (1990) organized learning outcomes into cognitive domain, affective domain, responsible environmental behavior, locus of control, and assumptions of personal responsibility. Here, EEd is defined as the process by which skills are provided for action strategies for investigation, instillation of sensitivity and appreciation for the environment, ability to be actively involved in remedies, ability to influence change, and realization of environmental behaviors, both negative and positive, along with affects therein.

Environmental Literacy: Stables and Bishop (2001) view environmental literacy as a broader entity than EEd. They explain that environmental literacy should not be viewed as a mere component of EEd, but examined in parallel to EEd. Hence, two very different terms and definitions of each should exist; there is no adherence to ecological agendas. Environmental literacy should be dependent on our perceptions and interpretations and not dictated (Stables & Bishop, 2001). Additionally, they explain that a strong sense of environmental literacy will exists as a multi-disciplinary approach to viewing environmental issues (e.g. relation of conservation in protected areas with that of ecological, economic, social, and aesthetic concerns). According to Stables and Bishop (2001) a strong conception of environmental literacy should entail the following: acknowledgment that our environment comes in many forms and goes beyond just the scientific; there are many correct ways of understanding the environment; environmental issues are viewed dichotomously through the eyes of varied cultural and social groups; distinctions should always exists amongst reacting (reading) and acting (writing) on environmental issues; understanding that what we can achieve is retained by the natural and semiotic resources available; and acknowledgment that our environmental impacts do have consequences.

Marcinkowski (1991) defines environmental literacy as being environmentally aware and sensitive with a respect for the natural world. He felt that knowledge of the inner workings of natural systems was pivotal. An environmentally literate individual would be aware of their environmental sense of place, and develop strategies and skills to approach environmental problems. An environmentally literate individual should be a steward of the land, and hence actively involved at all levels of environmental remediation towards a resolve.

Roth's (1992) definition for environmental literacy was based on three-phase functionality. It involved nominal, functional, and operational environmental literacy. Within each phase there is a knowledge strand, affective strand, skill strand, and a behavior strand. In nominal environmental literacy, literate individuals are familiar with the basic societal system (human interaction with nature). They possess sensitivity for the environment and are responsible for their actions. Environmentally literate individuals are proficient in identification of environmental problems, issues therein, and solutions. Environmentally literate individuals should be stewards (Roth, 1992). In addition to being nominally literate, within the framework of functional environmental literacy, individuals possess knowledge and understanding on a wide array of ecological, economic, geographic, religious, educational, and political concepts that deal with the environment. These individuals are skilled in environmental analysis and investigation, as well as the utilization of resources and strategies to achieve this. They have willingness to press environmentally driven ideas and concepts, and adhere to this criteria; this is reflected in their lifestyles. The operational leg of environmental literacy refereed to by Roth involves the utilization of scientific inquiry, based upon available evidence, to solve environmental problems. Environmentally literate individuals should be efficacious toward their resolve for environmental problems.

General Science Education Considerations

Science Education promotes a functional knowledge of the living world and its physical forces, spinning the social fabric of modern civilization through its relevance in everyday life (Barber, 1915). According to Barber (1915), courses in general science should entail the following: Unified logical development, the highest order education value, adaptability for adolescent minds, promotion of scientific thinking, and student empowerment to feel a sense of control over their environment and an appreciation of the significance of modern life.

The nineteenth century was distinguished from previous centuries through the characteristic scholastic achievements in general science marked by man's mastery of the forces of nature. These achievements of science revolutionized schools and everyday life (methods of heating, lighting, sanitation, obtaining food, etc.); opening new doors to a more modern society (Barber, 1915). Since 1939, the social significance and increasing importance of science has been recognized as vital component within school curriculum (Blair & Goodson, 1939). Historically, the aim of science education has been to instill habitual thinking from cause to effect, thence from effect to cause (Blair & Goodson, 1939). This would require science educators to instill knowledge of the living world and the physical forces that sustain the living world (Barber, 1915). The 1960s sparked a progressive movement toward the advancement of science education through introduction of inquiry-based science instruction (Hurd and Gallagher, 1968). During the late 1970s, a focus on teaching and learning science was prevalent; this was marked by the introduction of standardized testing in science (King et al., 2001).

According to Beane (1988) most often associated with effective science education are teaching strategies that reduce emphasis on memorization, increase application of student knowledge of their environment, model scientific ideas, foster scientific reasoning, use textbooks as resources rather than sole science knowledge base, promote literacy among all students regardless of race or gender, and tailor instruction based on prior assessments of students' knowledge.

The National Science Education Standards (NSES) (NRC, 1996) were established to guide the promotion of a scientifically literate society. The NSES demand a standard of quality in science education that provides all students with an opportunity to learn science (NRC, 1996). The set forth protocols embedded within the NSES promote the best of the current practices in science education (NRC, 1996). Previously, researchers have reported successful instruction in science education utilizing methodologies consistent with those presented in the NSES (American Association for the Advancement of Science, 1989).

As indicated in the NSES (NRC, 1996), the overall goals are to educate students who will be able to understand their natural world, utilize scientific processes and applications during everyday experiences, intelligently discuss scientific technology, and utilize scientific knowledge and understanding to extend professional success. The NSES promotes the following: science for all students; science as an action; the incorporation of intellectual and cultural traditions; improvements to science education as part of systemic education reform; scientific literacy; specified science content standards and curriculum; a firm scientific knowledge base; science inquiry; and science and technology.

Teacher Efficacy

For nearly thirty years, researchers have investigated teacher efficacy (Tschannen-Moran, Hoy, & Hoy, 1998). Since the earliest attempt to measure teacher efficacy with a two-item questionnaire (Armor et al., 1976), there has been significant progress in understanding what teacher efficacy is, how it is related to other variables such as student achievement, and how it can best be measured. Tschannen-Moran and colleagues (1998) proposed an integrated model to elucidate what is known about teacher efficacy, including its sources and consequences.

The supposition that teacher efficacy is a determinant of students' achievement, motivational levels, and their own self-efficacy beliefs has been challenged and confirmed (Tschannen-Moran & Hoy, 2001). Efficacy affects both a teachers' effort as well as the goals that ensue for their classroom (Tschannen-Moran & Hoy, 2001). Teacher beliefs are congruent with their mode of instruction (Brickhouse, 1989). Strong teaching efficacy results in more stringent planning and organization (Allinder, 1994), while weak teaching efficacy has been shown to substantially lower student achievement levels (King et al., 2001; Ashton & Webb, 1986).

Instructors' perceptions of their own thought patterns, beliefs, and feelings play a crucial role in their self perceptions. Commitment to these feelings effects their mode of perception and subsequently invokes a reaction that is based on those perceptions. According to Bandura (1986), individual's perceptions, beliefs, and feelings have a direct causal link to behavior, this is commonly referred to as self-efficacy, and is commonly referred to as teacher efficacy when related to curricular instruction.

Initially identified as one of few teacher characteristics representing a direct causal relationship to student achievement (Armor et al., 1976), teacher efficacy has since been coupled with innumerable variables relevant to student outcomes and achievement levels (Hoy, 2000). Teacher efficacy is simplistic in scope but its implications may be detrimental to student outcomes and achievements (Tschannen-Moran & Hoy, 2001). Teacher efficacy is a vital contributor to both student and teacher success and serves as an indicator of the extent instructors' perceive their ability to affect student outcomes, even students unmotivated or difficult to instruct.

One of the most pervasive constructs to present teacher efficacy was the Rand Corporation's evaluations of correlations among minority reading achievement and answers to questions presented within a research instrument (Berman et al., 1977; Armor et al., 1976). Likert-scale responses were employed to answer questions regarding the extent to which instructors believed they could control and affect change among student outcomes. Rotter's (1966) locus of control for social learning theories was the theoretical bases for the Rand Corporation's examined criteria. These findings were validated using Bandura's theory of judgment-based perceptions of capabilities, known as efficacy expectations, and results thereof which formulate one's outcome expectancy (Gibson & Dembo, 1984); hence, two factors of examination were created. The first factor is known as personal teaching efficacy (PTE), or self-efficacy, an instructors' belief in their own knowledge, skills, and abilities that - in effect - prepares them to present curricula in a championed manner (Gibson and Dembo, 1984). The second factor is known as general teaching efficacy (GTE) or outcome expectancy, which is an instructors' belief that they can in effect - affect - their student outcomes and achievement levels; these formulate the basis for Gibson and Dembo's (1984) Teacher Efficacy Scale.

In the 1980s and 1990s, the concept of teacher efficacy was refined. Gibson and Dembo (1984) created the Teacher Efficacy Scale, a 30-item instrument that provided a global measure of teacher efficacy and contained two subscales that measured PTE and GTE. These authors suggested that GTE corresponded to outcome expectancy (OE), the second component of Bandura's social cognitive theory in which a person assesses the likely consequences of the performance level he or she expects to achieve (Bandura, 1977). The Gibson and Dembo instrument stimulated teacher efficacy research and was widely used in studies that verified the importance of teacher efficacy as a construct (Tschannen et al., 1998).

Often grouped, many argue that the above two interactive factors (GTE and PTE) should be considered conceptually independent (Hoy, 2000). Some instructors view students' ability to learn as substantial, however these instructors may feel unequipped to properly instruct them. Other instructors may view their abilities as substantial, while viewing their students as incapable of learning. These two factors have only been demonstrated to be moderately related (Hoy, 2000).

Bandura's (1986) interpretation of outcome expectancy was the consequential judgments of a specified action based on preconceived notions of performance. Bandura (1986) goes on to explain that outcome expectancy does little to thoroughly present rationale for motivation levels. According to Bandura's (1986) social cognitive theory, an individual's knowledge, skills, and prior achievements are paltry predictive indicators of subsequent attainments as those achievements are based on that individuals' assessment of their own abilities and the outcome of their efforts. An individuals' expectations are directly proportional to interpretations of their capacity to perform a specific task and not a measurement of others circumstantial accomplishments (Bandura, 1986). Kirsch (1985) refuted Bandura's theory that outcomes expectancy is derived largely from judgments that are based on how well one executes a particular task and/or behavior. One could perceive that the outcome they could affect is beyond ones' control to do so. Thus, these outcome expectations are independent of the individuals' perceptions of their own abilities (Kirsch, 1985). Concurrence would later be given to the notion that items would reference outcomes that individual instructors could expect based on the perceptions of their abilities; original GTE measurements were considered flawed and could not be considered a stringent measurement for assessing outcome expectancy (Tschannen-Moran et al., 1998; Skinner, 1996; Emmer & Hickman, 1990; Woolfolk & Hoy, 1990).

Subsequent to the Rand study, several other efficacy studies were in concomitant development. Guskey's Responsibility for Student Achievement Assessment was developed to assess the extent an instructor bore responsibility for their students' outcomes; the teacher would decide whether an action was the result of their instruction or external factors outside their classroom. The Teacher Locus of Control was developed to correspond to the Rand items for GTE and PTE and was utilized as an indicator of instructors' willingness to adapt to new innovations. Finally, the Webb Scale's development would probe more positive factors associated with measurement of teacher efficacy. These methods were not extensively utilized prior to initial studies (Tschannen-Moran & Hoy, 2001).

Teacher Efficacy: Multi-Disciplinary Assessments. Teacher efficacy has been defined as both context and subject-matter specific (Tschannen et al., 1998); however, it is not clear as to the appropriate level of specificity for its measure (Tschannen-Moran & Hoy, 2001). Pintrich and Schunk (1996) have noted that the level of specificity is one of the most difficult issues to be resolved for cognitive or motivational theories that propose domain specificity. Thus, instruments have been developed to measure teacher efficacy within specific curriculum areas.

Accurate assessment of teachers' self-efficacy should cover their competence throughout a wide range of curricular subject matter, activities, and task performed in their classroom (Tschannen-Moran & Hoy, 2001). According to Zimmerman (1995) various domains of functioning exists upon which efficacy beliefs should be stratified into multi-dimensions. Pajares (1996) reported that the predictive value of efficacy assessments is diminished and/or nullified when efficacy beliefs are globally assessed with no specified criteria being compared. Predictive validity is enhanced when efficacy assessments are tailored to specified criteria and when assessment procedures regarding the criteria are stringently adhered to (Pajares, 1996).

To increase assessment validity and predictive accuracy, Bandura (1986) cautioned research attempts that failed to utilize assessments lacking specificity to critical tasks. Efficacy assessment should be of the highest specificity to the critical task and domain functioning being assessed (Pajares, 1996). Too often educational efficacy research assessments are too general and global with no comparability to the critical task or discipline to which they are assessing (Pajares, 1996). According to Bandura (1986), broad efficacy assessment approaches are omnibus instruments that are difficult to interpret and obscure initially targeted criteria being assessed.

A more practical application for efficacy assessments was applied to Gibson and Dembo's (1984) instrument to assess instructor efficacy within the context of specific curricular arenas. According to Tschannen-Moran and Hoy (1998), validated assessments of teacher efficacy must measure both personal competence as well as external constraints as related to teaching in order to achieve a concise assessment. Riggs and Enoch's (1990) Science Teacher Efficacy Beliefs Instrument (STEBI), combines both teaching efficacy (outcome expectancy) and PTE (self-efficacy) to address two dimensions of teacher self-efficacy. Tschannen-Moran and Hoy's (2001) Ohio Student Teacher Efficacy Scale (OSTES) also combines both outcome expectancy and self-efficacy, but they create three factors for analysis of teacher efficacy: instructional strategies (factor 1), efficacy for classroom management (factor 2), and efficacy for student engagement (factor 3). Sia (1992) developed an Environmental Education Efficacy Beliefs Instrument (EEEBI) containing scales for both self-efficacy and outcome expectancy.

Teacher Efficacy: Environmental Science Education. Although ES has become interdisciplinary in its curricular approaches and is being implemented within varying disciplines (Middlestadt et al., 1999; Sasse, 1997), examination of efficacy as it pertains to ES curriculum has been minimal. The need for stringent applications in preparation of teachers to implement ES curriculum has been described (Sia, 1992; Moseley et al., 2002). Utilizing Rigg's and Enoch's (1990) STEBI as a theoretical construct, the EEEBI (Sia, 1992) contained scales for both self-efficacy and outcome expectancy. Through utilization of the EEEBI, it was determined that while most pre-service teachers are in concurrence that if appropriately equipped with environmental training they will effectively enhance their students' knowledge base in ES (Sia, 1992), their negative self-efficacy beliefs demonstrated their lack of confidence in implementation of strategies to effectively relay environmental curriculum (Sia, 1992); thus, quickly nullifying the positive outcome expectancy beliefs exhibited by these instructors. Bandura (1996) suggests a theory that efficacy is most affected within the first year of instruction, which are the most pivotal to development of instructors' efficacy belief system.

Negative self efficacy beliefs toward ES curriculum may be highly attributed to a lack of adequate training (Sia, 1992). Moseley and colleagues (2002) found that limited exposure to EEd was not indicative of low self-efficacy beliefs. Additionally, EEd programs promoting the development of skills needed to effectively instruct ES appeared to have little impact on efficacy levels. However, a follow-up posttest did reveal a significant negative effect on instructors' efficacy levels for ES curriculum after completion of the EEd development program. This negative effect was attributed to lack of reinforcement in EEd curricula, methodology, and second guessing their abilities to adequately instruct ES curriculum.

Teacher Efficacy: Ethnicity and Science. The current situation involving science education in minority high schools is drastically incompatible with that of its non-minority counterparts (King et al., 2001). Due to high vacancies in minority schools, many teachers are labeled as being unqualified because they are placed in positions without adequate science education backgrounds (King et al., 2001). Dysfunctional trends in teacher placement can foster initial degradation of a teacher's sense of efficacy (Tchannen-Moran & Hoy, 2001). New teachers are often given lowest priority for the school in which they would thrive as successful instructors (Tchannen-Moran & Hoy, 2001). This often results in the pre-establishment, and more often that not, long-term adoption of lowered efficacy beliefs that result from feelings of ill preparedness, lack of enthusiasm, and a general dissatisfaction with their career status. Ferguson (1991) found that teachers in economically repressed schools, that serve minorities, are more likely to be ill qualified for current positions in science and mathematics. This was evidenced by low-test scores on teacher certification tests, paltry attempts at upper level collegiate science coursework, and/or a lack of college course work in science.

Situational criteria form the basis for teacher efficacy beliefs (Tschannen-Moran & Hoy, 2001). Perception of competence varies in accordance with subject matter as well as student make up (Tschannen-Moran & Hoy, 2001). Teachers' expectations influence their view of instructional limitation, which in turn influences their teaching efficacy (Rodney et al., 1986). Ethnicity, perceived intelligence, and academic performance have been shown to influence teachers' expectations (Rodney et al., 1986). Basic typecasting often governs reactions that perpetuate events affecting how people act, judge, decide, and solve problems (Anderson et al., 1988). Even experienced teachers have been shown to differentiate according to ethnicity; this behavior conveys messages that have deleterious effects on students' outcomes (Melnick & Raudenbusch, 1986).

Weener (1999) compared students' scientific interests within two schools differing drastically in their ethnic populations. When comparing attitudes towards science among non-minority and minority students, he found that while the level of scientific knowledge was higher for that of the non-minority group, minority groups demonstrated attitudes toward science that were more positive and their desire for increased science learning was greater than that of non-minorities. However, after primary years, these students' positive attitudes toward science may be quickly nullified through negative perceptions of minority student outcomes and achievement levels by their instructors.

The quality of science instructions is significantly dependent on the teachers approach (King et al., 2001). Science curriculum must consider multiple frames of reference and varied ways of learning and viewing the world of its learners (Aikenhead, 1996). Traditionally, teachers of minority students have believed that science reasoning and application was too challenging (King et al., 2001). Longitudinal research provides evidence that many teachers in economically depressed minority schools believe their students are incapable of extracting higher order principles from scientific disciplines (Beane, 1988), so many of these instructors abandon higher order methodologies. Despite findings of ill prepared science teachers and decreasing achievement in minority schools, very little empirical data has probed and highlighted causal links related to minority student achievement in science (King et al., 2001). According to Steele (1992), the American education system should provide constant reaffirmation that fosters self determination and positive criteria on which minority students can base beliefs in their educational achievements. At the root of minority achievement gaps is the failure of the American education system to instill such beliefs (Steele, 1992).

Teachers' classroom environment is a major determinant of their instructional effectiveness, which subsequently influences their own teaching efficacy. Ethnic classroom distribution can affect an instructors' overall classroom perspective and dynamic (McLaughlin & Talbert, 1993). Successful instruction of minorities has proved to be the result of stringent classroom expectations and positive beliefs for students by their instructors (Ladson-Billings, 1994). Meyer's (1985) believed outcome expectancy was not the only pivotal factor in efficacy considerations. An instructors' belief in their abilities to teach effectively, independent from their students, could be one of the most powerful factors. Instructors firmly grounded in their confidence to teach are less likely to engage in negative practices, thus decreasing the opportunity to implement negative devices that reject universalism, lower goals, and deem some groups as unreachable (Payne, 1994).

Science and Minorities

The late 1980s marked the onset of policy drawn towards the lack of diversity in the environmental movement (Taylor, 2005). In 1990, environmental justice activists targeted top environmental non-profit organizations regarding the lack of minority representation within their organizations (Taylor, 2005). Despite the rise in minority populations, relatively few hold careers within a professional capacity in an environmental field (Taylor, 2005). Initiatives such as the Minority Environmental Leadership Development Initiative and the Environmental Careers Organization Diversity Initiative are currently in place to addresses the critical need to increase diversity within the many fields of environmental science (Taylor, 2005).

Many studies have examined the differences in the level of minority versus non-minority involvement in environmental issues; assessing perceptions, attitudes, concerns, support level, knowledge, and environmental awareness (Taylor, 1989). Many theories are hypothesized to account for theses differences (Taylor, 1989). Although some minorities have developed thriving careers in a wide range of environmental professions (Taylor, 2005), past studies trace a significantly lower level of environmental interest among minorities when compared to that of non-minorities (Taylor, 1989).

Historically, minorities have been underrepresented in the sciences (Wenzel, 2003). Considerable discussion has been generated concerning efforts to improve diversity within the scientific community (Wenzel, 2003). The Science Technology Equal Opportunities Act called for the National Science Foundation (NSF) to increase the contributions of minorities in scientific, professional, and technical careers, yet minorities remain woefully underrepresented within scientific fields (Nocera et al, 1996). Leslie and colleagues (1998) described this problem as an issue of national priority due to social equity issues as well as the quality of United States labor involved.

The current technological society and many routine daily activities demand sound scientific literacy; however few minority students are receiving a knowledge base that promotes this (Clewell et al., 1995). The current job market commands skills that require individuals to learn, reason, think creatively, make decisions, and solve problems based upon an understanding of essential scientific concepts and its role within every day existence (NRC, 1996).

The National Center for Educational Statistics (2001) reported that White students produced significantly higher scores in science, on average, than that of both Black and Hispanic students; these 'average' gaps have remained constant since 1996. Results from the ACT standardized test (formerly known as "American College Testing") yielded similar findings in that minorities' science scores were significantly lower than that of their non-minority counterparts. The 2003 ACT composite scores in science for Blacks, Hispanics, and Whites were 17.2, 19.0, and 21.6 respectively. Although beneficial, this type of assessment fails to probe the opportunity of students to learn science and has the potential to create biases in proper determination of students' actual scientific knowledge base and abilities to learn science (NRC, 1996).

Students' science learning is greatly influence by how they are taught and their instructors are deeply influenced by the way they interact with and understand their students (NRC, 1996). According to Steele (1992), embedded within most American educators' belief system is the notion that minority students need academic remediation and/or extra time to overcome curricular deficits. This notion has proven detrimental to the minority achievement gap in education (Steele, 1992). Often, when deficits in achievement are noted for minority students, the level of instruction is continually reduced to assist the student, resulting in a perpetual cascade of lessened instruction that results in an overall handicap in minority student success (Steele, 1992). Assessments that measure instructors' scientific knowledge base, available time, professional knowledge, efficacy for science instruction, and their efficacy for science instruction within cross ethnic environments, should all be determining factors in the overall assessment of students' science knowledge base on standardized tests.

According to the NSES (NRC, 1996), results from standardized tests (e.g. ACT) should affect policy change and guide professional development of teachers towards strengthening their abilities to effectively teach science to students of varied diversities, experiences, and backgrounds; yet this perpetual gap in minorities' science scores on standardized tests and lack of overall participation in science related fields has done very little to effect policy changes within science education. Assessment and evaluation systems should not be bias, and should reflect the actual curriculum being presented in science classrooms; thus giving education stakeholders an information base to act upon. This information should provide stakeholder with the necessary knowledge to invoke curricular change within science classrooms, diagnose substantive student issues, identify misconceptions, and assess the effectiveness of science instructors (Kulm and Malcom, 1991).

According to the NSF (2004), 62,089 Bachelor's degrees were awarded in the field of Biological Science in 2001. Of these recipients, only 4,693 degrees were awarded to Blacks; 41,325 were awarded to Whites. Additionally, of the 5,614 Master's degrees awarded within the Biological Sciences in 2001, only 313 of these recipients were Black; 4,124 were White. Doctoral degrees awarded within the area of Biological Sciences followed a trend similar to those above. Of the 4,088 Doctoral degrees awarded, 78 were awarded to Blacks while 3,105 were White recipients. According to these figures, the percentages for degrees awarded to Blacks in the Biological Sciences for Bachelor's, Masters, and Doctorates were 7.6%, 5.6%, and 1.9% respectively – for Whites these percentages were 67.0%, 74.0%, and 76.0% respectively. A disproportion can be evidenced when these figures are compared to the standard demographic populace for the United States, of which Blacks represent 12.2% and Whites represent 68.9% (NSF, 2004).

Equity considerations are a crucial factor within science teaching standards (NRC, 1996). An effective science instructor views all students as capable of interjecting useful contributions during science leaning (NRC, 1996). Science Instructors should emphatically reject situations were individuals are discouraged from pursuing science and excluded from opportunities to learn science. Negative attitudes and stereotypes have been demonstrated to created barriers between minority students and their instructors; often resulting in resistance to the instructor, both personally and socially (Payne, 1994). Negative preconceptions from instructors based on socioeconomic and/or race impair the process by which minority students are motivated and distort the way their achievements are shaped (Payne, 1994). It has been proven that attitudes based on misconceptions and preconceived notions yield detrimental effects on the motivation and achievement levels of minority students (Payne, 1994). Equity should pervade all aspects of science learning (NRC, 1996).

Further Considerations

This literature review has been designed to provide an overview of relevant literature and research in relation to the scope of this study. The preceding study utilizes science teacher efficacy as a tool to probe rationale underlying the under-representation of minorities within the many disciplines of environmental science, a crucial component of general science education.

CHAPTER III

METHODOLOGY

I. Purpose and rationale for survey design selection:

The purpose of the research instrument utilized here was to assess environmental and general science teacher efficacy for instructors with contrasting class ethnicity distributions (CED) (minority vs. non-minority). In order to achieve a concise assessment of teacher efficacy levels, research instruments should cover competence throughout a wide range of curricular subject matter, personal competence, external constraints, activities, and tasks performed in the classroom (Tschannen-Moran & Hoy, 2001). To achieve this, a modified research instrument combined the Environmental Education Efficacy Belief Instrument (EEEBI) (Sia, 1992), the Science Teaching Efficacy Beliefs Instrument (STEBI) (Riggs & Enochs, 1990), and factors 2 & 3 from the Ohio State Teacher Efficacy Scale (OSTES) (Tschannen-Moran & Hoy, 2001) to create a bi-disciplinary Environmental and General Science Teacher Efficacy Assessment (EGSTEA).

This unique approach to efficacy assessments not only examined elements that affect teachers' personal beliefs, it also examined external factors that impede instructors' abilities to present classroom information adequately, providing a more concise assessment of efficacy levels. This bi-disciplinary, four dimensional assessment was utilized to measure personal teacher efficacy (PTE), general teacher efficacy or outcome expectancy (OE), classroom management (CM), and student engagement (SE) concomitantly for both the environmental and general science disciplines. Additionally, instructors' willingness to, and utilization of, practical instruction to reinforce science learning was also assessed.

The findings presented as a result of this research will drive future research determinations on the down-stream effects efficacy may have on students' own self-efficacy and achievement

II. Instrumentation

The EGSTEA was modified from the EEEBI (Sia, 1992), the STEBI (Riggs & Enochs, 1990), and factors 2 & 3 from the OSTES (Tschannen-Moran & Hoy, 2001).

Modified from the STEBI, the EEEBI reflected future environmental education belief and contained 23 statements addressing PTE and OE. The EEEBI utilized a 5 point Likert-scale response format that ranged from strongly agree (5) to strongly disagree (1). The validity of this instrument is reportedly high (Sia, 1992). Moseley and colleagues (2002) reported high instrument reliability marked by a Guttman split-half coefficient of 0.9132.

The STEBI contained 23 statements addressing personal science teaching efficacy (PSTE) and science teacher outcome expectancy (STOE). The STEBI utilized the same Likert - scale response format as previously mentioned. Negatively phrased statements were reverse-coded prior to analysis of collected data. The STEBI was reliable and valid with a reported coefficient alpha of 0.92 for the PSTE and 0.77 for the STOE as reported by Riggs and Enochs (1990).

Factors 2 and 3 of the OSTES contained 16 questions; Factor 2 contained 8 questions that addressed classroom management (CM) and Factor 3 contained 8 questions that addressed student engagement (SE). Tschannen-Moran and Hoy (2001) reported high reliabilities for these two factors, with reported coefficient alphas of 0.90 and 0.87 for Factors 2 and 3 respectively.

Modified from the above validated research instruments, the EGSTEA presented here, employed a bi-disciplinary, four dimensional assessment to examine both environmental and general science efficacy (Appendix A). The first dimension, PTE for environmental and general science modified from the STEBI and the EEEBI, was embedded within questions 2, 3, 5, 6, 8, 12, and 17-23. The second dimension, OE for environmental and general science modified from the STEBI and the EEEBI, was embedded within questions 1, 4, 7, 9-11, and 13-16. The third dimension, CM modified from the OSTES, was embedded within questions 26-33. Finally, the fourth dimension, SE modified from the OSTES, was embedded with questions 34-41.

Additional data collected included questions 24 and 25, these questions addressed instructors' extent of, and willingness to, utilize outdoor classrooms to reinforce science learning. These questions were addressed individually according to mean Likert-scale response score (efficacy response), and were not included in the four dimensional efficacy assessment. Other data collected included classroom information (number of students instructed per day and student ethnicities) and teacher information (instructor years experience, instructor ethnicity, instructor age, and instructor gender).

Reliability for the EGSTEA was determined to be high with a Cronbach's Alpha of 0.952 (EE) and 0.951 (GSE) for the entire instrument. Reliability for subscales (efficacy dimensions) was determined to be high with Cronbach's Alphas of 0.632 (EE) and 0.611 (GSE) for OE, 0.958 (EE) and 0.957 (GSE) for PTE, 0.851 for CM, and 0.865 for SE.

III. Participants

Research participants consisted of a convenience sample of high and middle school science instructors employed within various school districts statewide. A single stage sampling procedure was utilized. Contact information for science instructors was obtained through district websites and State Department science education contacts. Instructors were solicited via phone for their participation and research instruments were distributed accordingly. Also, research instruments were distributed to Science Department heads and/or school science curriculum points of contact for distribution to science instructors in their schools. Forty science instructors participated as marked by submission of 40 completed research questionnaires via mail.

The cumulative number of students taught per day by all 40 participants totaled 4116 students. Of these students 401 students were Hispanic (9.7%), 1348 students were Black (32.7%), 2016 students were white (48.9%), 42 students were Asian (1%), 216 students were American Indian (5.2%), and 99 students were considered an ethnicity other than those listed (2.4%). For the purposes of this study, the term minority referred to students who are Hispanic, Black, or American Indian; the term non-minority referred to students who are White only. Data were stratified based on CED (minority vs. non-minority). Class ethnicity distribution was based on greater than fifty percent ethnicity majority. Because of low variable numbers and unclear minority/non-minority designation as an underrepresented American ethnicity, students of Asian and/or other ethnicities were not utilized in criteria for determination of CED in this study.

Of the forty research participants in this study, 22 instructors had high minority student populations; classrooms labeled high minority CED contained a mean average of 74% minority students. The remaining 18 instructors had high non-minority student populations; classrooms labeled high non-minority CED contained a mean average of 72% non-minority students.

Instructor gender consisted of 18 male instructors and 22 female instructors. Science instructor demographics consisted of 31 white, 2 White/American Indian, 5 American Indian, and 2 Black. There were 17 instructors having greater than ten years teaching experience; 23 instructors had less than ten years teaching experience. There were 14 instructors teaching at the middle school grade level and 26 instructors teaching at the high school grade level. For the purpose of this study, middle school designation ranged from 6^{th} to 8^{th} grade and/or 6^{th} to 9^{th} grade if the 9^{th} grade designation was associated with a middle school. High school ranged from 9^{th} to 12^{th} grades and/or 10^{th} to 12^{th} grades depending on the above 9^{th} grade designation.

IV. Research Questions:

The following research questions were addressed to examine variations in mean level environmental and general science efficacy among instructors with contrasting CED (minority vs. non-minority):

a. Is there a significant difference in mean environmental and general science efficacy scores for instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE), do mean efficacy response scores differ for instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

b. Is there a significant difference in mean environmental and general science efficacy scores for instructors who differ in years teaching experience (greater vs. less than 10 years) and have contrasting class ethnicity distributions (minority vs. non-minority)?

c. Is there a significant difference in mean environmental and general science efficacy scores for high and middle school instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE) among instructors of high and middle school students, do mean efficacy response scores differ among instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

d. Does instructor gender (male vs. female) effect mean environmental and general science efficacy scores among instructors with contrasting class ethnicity distributions (minority vs. non-minority)? When comparing environmental and general science efficacy dimensions (PTE, OE, CM, and SE), do mean efficacy response scores differ among male and female instructors with contrasting class ethnicity distributions (minority vs. non-minority)? Where are these differences most evidenced?

e. What are the attitudes among instructors on practical applications for environmental instruction? Do attitudes differ among male and female instructors? Do attitudes differ among instructors with greater than 10 years experience when compared to that of instructor with less than ten years experience. Is there a difference in attitudes when the aforementioned variables are examined among instructors with contrasting class ethnicity distributions (minority vs. non-minority)?

f. Do variations exist among science instructors' extent of, and willingness to, utilize practical environmental instruction when comparing instructors with contrasting class ethnicity distributions? Is there a difference among willingness to, and utilization of, outdoor classrooms when comparing male and females or when examining instructor years teaching experience?

V. Sampling Procedure

Science instructors (n = 40) were asked to complete a 41 item research instrument (see Appendix A) using a 5 point Likert-scale response format. Categories for assessment were “strongly disagree”, “disagree”, “uncertain”, “agree”, and “strongly agree”. After detailed verbal explanation of consent form (see Appendix B), instructors were issued a packet containing research questionnaire and supplemental teacher information form (see Appendix C). Instructor participation in this process was anonymous. No follow-up procedures were initiated after receipt of completed research instrument. Data was collected within last two months of academic school year 2005. Data collection was complete upon onset of official summer vacation. Instructors mailed completed research instrument using stamped self-addressed envelope provided.

Institutional Review Board (IRB). Prior to solicitation of research participants and/or implementation of any stage in participant interaction, a research proposal, research instrument, and consent form were approved through the Oklahoma State University Institutional Review Board. Federal Policy requires said purview and approval prior to commencement of research activities. This research was granted permission to proceed under IRB number AG-05-39 (see Appendix D). Written consent forms were explained and completed prior to completion of the research instrument.

VI. Data Analysis

Forty research instruments were received, completed and accompanied by appropriate consent form. Each response was assigned a score from 1 to 5 with respect to the following responses: "strongly disagree", "disagree", "uncertain", "agree", and "strongly agree". Negatively phrased questions were scored in the opposite direction and positively recoded to obtain a total score for the entire instrument. The possible range of composite scores for the survey was 39-195. Total composite score excluded questions 24 and 25 for consistency with past efficacy studies; responses for these questions are addressed separately.

It should be noted that efficacy dimension variables (PTE, OE, CM, SE) could not be compared based on a composite score total as the number of statements within each dimension was not equivalent. The PTE dimension contained 13 statements, the OE dimension contained 10 statements, the CM dimension contained 8 statements, and the SE dimension contained 8 statements. Instead of comparing mean efficacy score (research instrument total score), mean Likert-scale response score (i.e. 1 – 5) was examined to compare and contrast efficacy dimension variables.

VI. Statistical Analysis

Data were stratified to compare the effect of the following variables on mean efficacy levels (Table 3-1): Class Ethnicity Distribution, Science Discipline, Instructor Gender, Grade Level, Years Teaching Experience, Outdoor Classroom Utilization, Efficacy, and Efficacy Dimension. Two-way ANOVA with Bonferroni post test (Table 3-2) along with generation of graphed data was performed using GraphPad Prism version 4.00 for Windows, GraphPad Software, San Diego California USA, www.graphpad.com. One-way ANOVA was also employed for one variable analysis (Table 3-3).

Table 3-1. Analysis Variables.

Variables
1. **Class Ethnicity Distribution** *(independent)*:
Minority
Non-Minority
2. **Science Discipline** *(independent)*:
Environmental Science
General Science
3. **Instructor Gender** *(independent)*:
Male
Female
4. **Grade Level** *(independent)*:
High School
Middle School
5. **Years Teaching Experience** *(independent)*:
10 years (+)
10 years (-)
6. **Outdoor Classroom Utilization** *(dependent)*:
Extent of utilization
Willingness to utilize
7. **Efficacy** *(dependent)*:
Environmental Science
General Science
8. **Efficacy Dimension** *(dependent)*:
Environmental Science
Personal Teaching Efficacy
Outcome Expectancy
Classroom Management
Student Engagement
General Science
Personal Teaching Efficacy
Outcome Expectancy
Classroom Management
Student Engagement

Table 3-2. Summary of variable arrangements utilized to generate Two-way ANOVA analyses and graphs.

	Class Ethnicity Distribution	
Science Discipline	Minority	Non-Minority
Environmental Science		
General Science		

	Class Ethnicity Distribution	
Efficacy Dimension	Minority	Non-Minority
Environmental Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
General Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		

	Years Teaching Experience	
Science Discipline	10 years (+)	10 years (-)
Environmental Science		
General Science		

	Class Ethnicity Distribution	
Years Teaching Experience	Minority	Non-Minority
10 years (+)		
10 years (-)		

	Class Ethnicity Distribution	
Grade Level	Minority	Non-Minority
Environmental Science		
High School		
Middle School		
General Science		
High School		
Middle School		

	Class Ethnicity Distribution	
Efficacy Dimension	Minority	Non-Minority
Environmental Science		
High School		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
Middle School		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
General Science		
High School		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
Middle School		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		

	Science Discipline	
Grade Level	Environmental Science	General Science
Environmental Science		
High School		
Middle School		
General Science		
High School		
Middle School		

	Grade Level	
Efficacy Dimension	High School	Middle School
Environmental Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
General Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		

	Class Ethnicity Distribution	
Instructor Gender	Minority	Non-Minority
Environmental Science		
Male		
Female		
General Science		
Male		
Female		

	Instructor Gender	
Efficacy Dimension	Male	Female
Environmental Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		
General Science		
Personal Teaching Efficacy		
Outcome Expectancy		
Classroom Management		
Student Engagement		

	Class Ethnicity Distribution	
Instructor Gender	Minority	Non-Minority
Extent of outdoor classroom utilization		
Male		
Female		

	Class Ethnicity Distribution	
Years Teaching Experience	Minority	Non-Minority
Extent of outdoor classroom utilization		
10 years (+)		
10 years (-)		

	Class Ethnicity Distribution	
Instructor Gender	Minority	Non-Minority
Willingness to utilize outdoor classroom		
Male		
Female		

	Class Ethnicity Distribution	
Years Teaching Experience	Minority	Non-Minority
Willingness to utilize outdoor classroom		
10 years (+)		
10 years (-)		

Table 3-3. Summary of variable arrangements utilized to generate t-tests analyses and graphs.

Willingness to utilize outdoor classroom	
Years Teaching experience	
10 years (+)	10 years (-)

Extent of outdoor classroom utilization	
Class Ethnicity Distribution	
Minority	Non-Minority

CHAPTER IV

RESULTS

I. RESEARCH QUESTION: Is there a significant difference in mean environmental and general science efficacy scores for instructors with contrasting class ethnicity distributions (minority vs. non-minority)?

Instructors with high percent minority class ethnicity distribution (CED) exhibited significantly lower ($p < 0.0001$) environmental and general science efficacy scores when compared with that of instructors with high percent non-minority CED (Figure 4-1). Two-way ANOVA revealed that CED had a significant effect on environmental and general science efficacy scores (Table 4-1). When comparing efficacy scores for only instructors with high minority CED, there was not a significant difference ($p > 0.05$) for either science discipline; likewise, when comparing efficacy scores for only instructors with high non-minority CED, there was not a significant difference ($p > 0.05$) for either science discipline (Table 4-2). Additionally, when differences between environmental efficacy (EE) scores and general science efficacy (GSE) scores were compared, there was not a statistically significant difference ($p < 0.05$); hence, there was not an effect of science discipline on science teacher efficacy levels (Table 4-1).

Two-way ANOVA of CED and efficacy dimension revealed that CED had a significant effect on mean EE and GSE responses for classroom management (CM) and student engagement (SE) (Figure 4-2; Tables 4-4 and 4-5). Bonferroni posttests revealed that instructors with high percent minority CED exhibited significantly lower efficacy responses for CM ($p < 0.01$) and SE ($p < 0.05$) than that of instructors with high non-minority CED (Table 4-5). Consequently, as indicated in Figure 4-2, mean efficacy responses were consistently higher for instructors with high percent non-minority CED for all 4 dimensions of both EE and GSE when compared to that of instructors with high minority CED. However, there was not a statistically significant difference ($p > 0.05$) for the efficacy dimensions of personal teaching efficacy (PTE) or outcome expectancy (OE) when comparing efficacy responses for instructors with contrasting CED; these results were consistent for both the general and environmental science disciplines (Table 4-5).

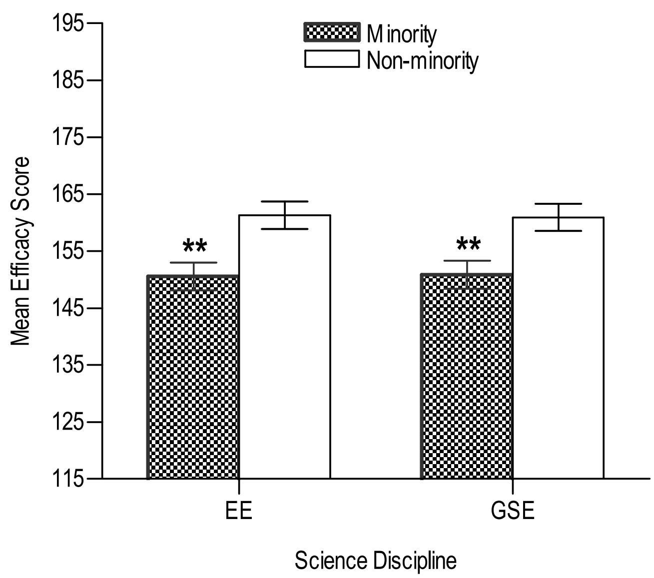

Figure 4-1. Effect of class ethnicity distribution (minority *n=22* vs. non-minority *n=18*) and science discipline (environmental vs. general) on mean instructor efficacy score. Asterisks represent mean efficacy scores significantly lower ($p < 0.01$) than paired group means.**

Table 4-1. Two-way ANOVA: Effect of class ethnicity distribution and science discipline (environmental and general) on mean efficacy score.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	2146	2146	18.01	$p < 0.0001$
Science Discipline	1	0.06679	0.06679	0.0005605	0.9812
Interaction	1	2.167	2.167	0.01818	0.8931
Residual (error)	76	9057	119.2		
Total	79				

Table 4-2. Summary of Bonferroni posttest for Table 4-1 two-way ANOVA.

Science Discipline	Minority	Non-Minority	t	*p* value
EE	150.6	161.3	3.096	$p < 0.01$
GSE	150.9	160.9	2.906	$p < 0.01$

Table 4-3. General statistical data summary.

Science Discipline	Mean	SEM	N
EE	155.425	1.902053	40
GSE	155.4	1.888155	40

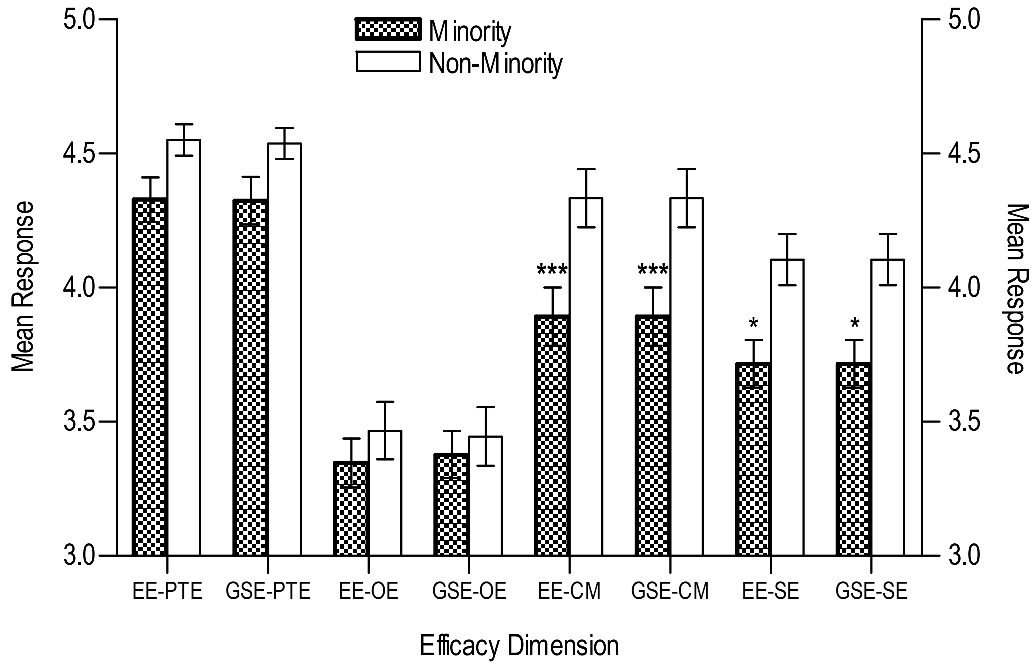

Figure 4-2. Effect of class ethnicity distribution (minority *n=22* vs. non-minority *n=18*) and efficacy dimension (personal teaching efficacy, outcome expectancy, classroom management, and student engagement) on mean environmental and general science efficacy responses. Asterisks represent mean efficacy scores significantly lower (*$p < 0.001$ / *$p < 0.05$) than paired group means.**

Table 4-4. Two-way ANOVA: Effect of classroom ethnicity distribution and efficacy dimension on mean environmental and general science efficacy scores.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	6.452	6.452	36.03	$p < 0.0001$
Efficacy Dimension	7	44.06	6.294	35.15	$p < 0.0001$
Interaction	7	1.52	0.2171	1.212	0.2956
Residual (error)	304	54.44	0.1791		
Total	319				

Table 4-5. Summary of Bonferroni posttests for Table 4-4 two-way ANOVA.

Efficacy Dimension	Minority	Non-Minority	t	*p* value
EE-PTE	4.329	4.551	1.655	$p > 0.05$
GS-PTE	4.325	4.538	1.586	$p > 0.05$
EE-OE	3.345	3.467	0.9013	$p > 0.05$
GS-OE	3.377	3.444	0.4995	$p > 0.05$
EE-CM	3.892	4.333	3.281	$p < 0.01$
GS-CM	3.892	4.333	3.281	$p < 0.01$
EE-SE	3.716	4.104	2.887	$p < 0.05$
GS-SE	3.716	4.104	2.887	$p < 0.05$

Additionally, two-way ANOVA also revealed that efficacy dimension had a significant effect on instructor efficacy responses (Table 4-6). When GSE and EE responses were examined for instructors with high minority CED only, PTE responses were the highest of the four efficacy dimensions, followed by CM, SE, and OE respectively. Within minority classrooms, instructor mean efficacy responses for PTE were significantly higher than mean efficacy responses for OE ($p < 0.001$), CM ($p < 0.01$), and SE ($p < 0.001$); mean OE efficacy responses were significantly lower than SE ($p < 0.05$) and CM ($p < 0.001$) efficacy scores. Within minority classrooms, OE and SE were the lowest responses, significantly lower (GSE $p < 0.05$; EE $p < 0.001$) than efficacy responses for both PTE and CM. There was not a significant difference ($p > 0.05$) between efficacy responses for CM and SE. When efficacy responses were examined for instructors with high percent non-minority students only, the results were consistent with that of minority classrooms with the exception of *p* values; PTE was only significantly higher at the 0.05 level for CM and at the 0.01 level for SE; OE was significantly lower than SE at the 0.001 level (Table 4-6).

Table 4-6. Summary of Bonferroni posttest for two-way ANOVA of efficacy dimension and class ethnicity distribution.

Class Ethnicity Distribution	GSE-PTE	GSE-OE	t	*p* value
Minority	4.325	3.377	7.429	$p < 0.001$
Non-Minority	4.538	3.444	7.756	$p < 0.001$
	GSE-PTE	**GSE-CM**	**t**	***p* value**
Minority	4.325	3.892	3.395	$p < 0.01$
Non-Minority	4.538	4.333	1.454	$p < 0.05$
	GSE-PTE	**GSE-SE**	**t**	***p* value**
Minority	4.325	3.716	4.775	$p < 0.001$
Non-Minority	4.538	4.104	3.079	$p < 0.01$
	GSE-OE	**GSE-CM**	**t**	***p* value**
Minority	3.377	3.892	4.035	$p < 0.001$
Non-Minority	3.444	4.333	6.302	$p < 0.001$
	GSE-OE	**GSE-SE**	**t**	***p* value**
Minority	3.377	3.716	2.654	$p < 0.05$
Non-Minority	3.444	4.104	4.677	$p < 0.001$
	GSE-CM	**GSE-SE**	**t**	***p* value**
Minority	3.892	3.716	1.381	$p > 0.05$
Non-Minority	4.333	4.104	1.625	$p > 0.05$

	EE-PTE	EE-OE	t	*p* value
Minority	4.329	3.345	7.706	$p < 0.001$
Non-Minority	4.551	3.467	7.689	$p < 0.001$
	EE-PTE	**EE-CM**	**t**	***p* value**
Minority	4.329	3.892	3.422	$p < 0.01$
Non-Minority	4.551	4.333	1.545	$p < 0.05$
	EE-PTE	**EE-SE**	**t**	***p* value**
Minority	4.329	3.716	4.803	$p < 0.001$
Non-Minority	4.551	4.104	3.17	$p < 0.01$
	EE-OE	**EE-CM**	**t**	***p* value**
Minority	3.345	3.892	4.284	$p < 0.001$
Non-Minority	3.467	4.333	6.144	$p < 0.001$
	EE-OE	**EE-SE**	**t**	***p* value**
Minority	3.345	3.716	2.904	$p < 0.01$
Non-Minority	3.467	4.104	4.52	$p < 0.001$
	EE-CM	**EE-SE**	**t**	***p* value**
Minority	3.892	3.716	1.381	$p < 0.05$
Non-Minority	4.333	4.104	1.625	$p < 0.05$

II. Research Question: <u>Is there a significant difference in mean environmental and general science efficacy scores for instructors who differ in years teaching experience (greater vs. less than 10 years) and have contrasting class ethnicity distributions (minority vs. non-minority)?</u>

Two-way ANOVA of instructor experience and science discipline revealed that instructors with less than 10 years experience exhibited significantly lower ($p < 0.01$) mean scores for both GSE and EE (Figure 4-3; Table 4-7); hence there was an effect of instructor experience level on mean efficacy score.

Two-way ANOVA revealed that CED and years teaching experience had a significant effect on mean EE and GSE scores, CED at $p < 0.0001$ and years teaching experience at $p < 0.001$. Mean efficacy scores for instructors with greater than 10 years teaching experience were compared based on CED. As shown in Figure 4-4, instructors with high percent minority CED exhibited lower mean efficacy scores than that of instructors whose CED is non-minority. However, these differences were not considered statistically significant ($p > 0.05$) when compared to mean efficacy scores for instructors with high non-minority CED as indicated in posttests (Table 4-9). Results were consistent for both science disciplines.

Mean efficacy scores were also compared for instructors with less than 10 years teaching experience based on CED. As shown in Figure 4-4, instructors with high minority CED with less than 10 years experience exhibited a significantly lower (GSE $p < 0.05$; EE $p < 0.01$) mean efficacy scores when compared to instructors of the same level experience with high non-minority CED (Tables 4-8 and 4-9) .

Consequently, although the differences in mean efficacy scores for Instructors having greater than 10 years teaching experience are not considered statistically significant, mean efficacy scores for both experience levels were consistently lower for instructors with high percent minority

CED. These results were consistent for both science disciplines with the exception of the noted *p* values (Figure 4-4; Table 4-9).

There was also an effect of CED on mean efficacy levels for instructors at both experience levels examined (Table 4-8). When comparing mean efficacy scores for instructors with high percent minority CED only, instructors having greater than 10 years teaching experience exhibited significantly higher ($p < 0.01$) efficacy scores than that of instructors having less than 10 years experience. There was not a significant difference ($p > 0.05$) in mean efficacy scores when comparing experience levels for instructors with high non-minority CED. The results were consistent for both GSE and EE scores.

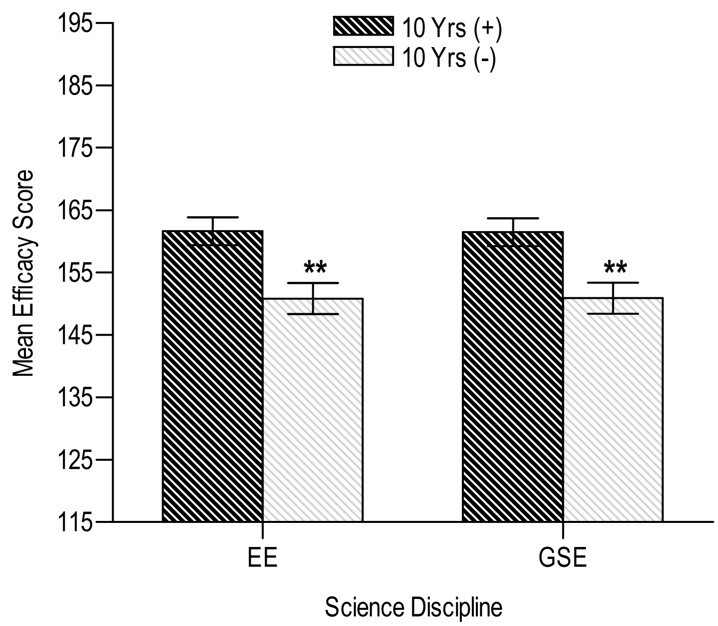

Figure 4-3. Effect of years teaching experience (greater *n=17* vs. less *n=23* than 10 years teaching experience) and science discipline (environmental vs. general) on mean environmental and general science efficacy scores. Asterisks represent mean efficacy scores significantly lower ($p < 0.01$) than paired group means.**

Table 4-7. Two-way ANOVA: Effect of years teaching experience and science discipline (environmental and general) on mean efficacy scores.

Source of Variation	Df	SS	MS	F	*p* value
Years Experience	1	2234	2234	18.92	$p < 0.0001$
Science Discipline	1	0.03916	0.03916	0.0003318	0.9855
Interaction	1	0.3392	0.3392	0.002873	0.9574
Residual (error)	76	8971	118		
Total	79				

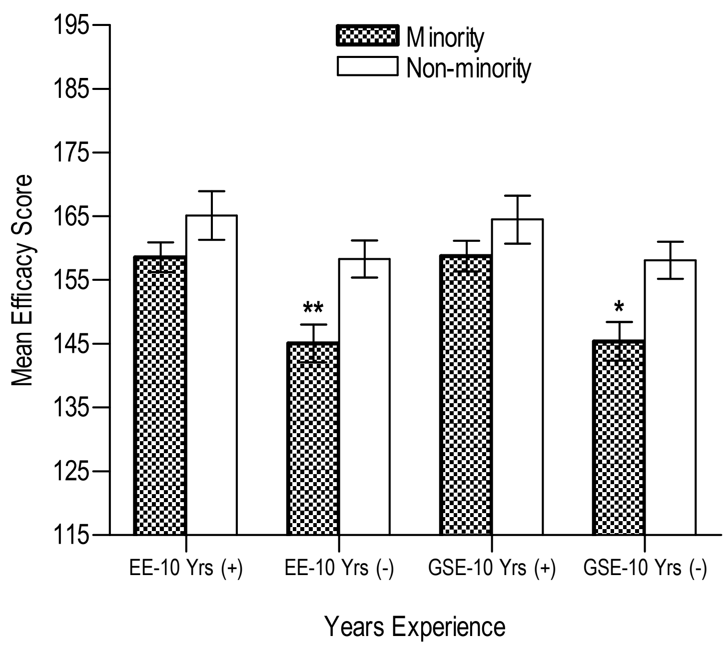

Figure 4-4. Effect of class ethnicity distribution (minority vs. non-minority) and years teaching experience (greater vs. less than 10 years teaching experience) on mean environmental and general science efficacy scores. Asterisks represent mean efficacy scores significantly lower ($p < 0.01$ / *$p < 0.05$) than paired group means. *[10 yrs(+) CED minority n=9/CED non-minority n=8; 10Yrs(-) CED minority n=13/CED non-minority n=10]***

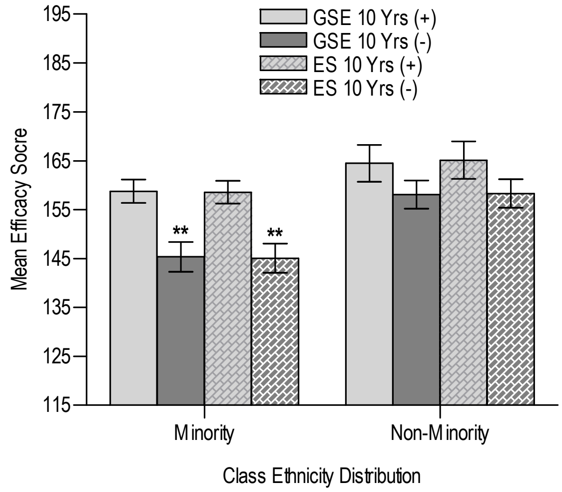

Figure 4-5. Effect of years teaching experience (greater vs. less than 10 years teaching experience) and class ethnicity distribution (minority vs. non-minority) on mean environmental and general science efficacy scores. Asterisks represent mean efficacy scores significantly lower (*p* < 0.01) than paired group means.** ***[10 yrs(+) CED minority n=9/CED non-minority n=8; 10Yrs(-) CED minority n=13/CED non-minority n=10]***

Table 4-8. Two-way ANOVA: Effect of class ethnicity distribution and instructor years experience on environmental and general science efficacy.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	1769	1769	18.88	$p < 0.0001$
Years Experience	3	1947	648.9	6.924	0.0004
Interaction	3	227.7	75.9	0.8099	0.4925
Residual (error)	72	6748	93.72		
Total	79				

Table 4-9. Summary of Bonferroni posttest for Table 4-8 two-way ANOVA.

Years Experience	Minority	Non-Minority	t	*p* value
EE-10 Yrs (+)	158.6	165.1	1.397	$p > 0.05$
EE-10 Yrs (-)	145.1	158.3	3.247	$p < 0.01$
GSE-10 Yrs (+)	158.8	164.5	1.216	$p > 0.05$
GSE-10 Yrs (-)	145.4	158.1	3.123	$p < 0.05$

III. RESEARCH QUESTION: Is there a significant difference in mean environmental and general science efficacy scores for high and middle school instructors with contrasting class ethnicity distributions (minority vs. non-minority)?

Mean efficacy scores were compared for middle and high school instructors with contrasting CED. As seen in Figures 4-6 and 4-7, there were markedly lower mean efficacy scores for instructors with high minority CED when compared to that of instructors with high non-minority CED; these results were consistent for middle and high school science instructors for both the environmental and general science disciplines. Although mean efficacy scores were consistently lower for high and middle school instructors with high minority CED, two-way ANOVA of CED and grade level (high and middle school) revealed that CED had a significant effect ($p < 0.05$) on mean efficacy scores; the effect of grade level was not considered significant ($p > 0.05$) (Tables 4-10 and 4-11). Bonferroni posttests revealed a statistically significant difference ($p < 0.05$) in mean efficacy scores when comparing only high school instructor efficacy with contrasting CED (Tables 4-12 and 4-13). High school instructors with high percent minority CED had a significantly lower ($p < 0.05$) mean efficacy score than that of high school instructors with high non-minority CED (Figures 4-6 and 4-7). Although middle school instructors with high minority CED exhibited consistently lower efficacy scores than instructors with high non-minority CED, there was not a statistically significant difference ($p > 0.05$) between compared group means (Figures 4-6 and 4-7) .

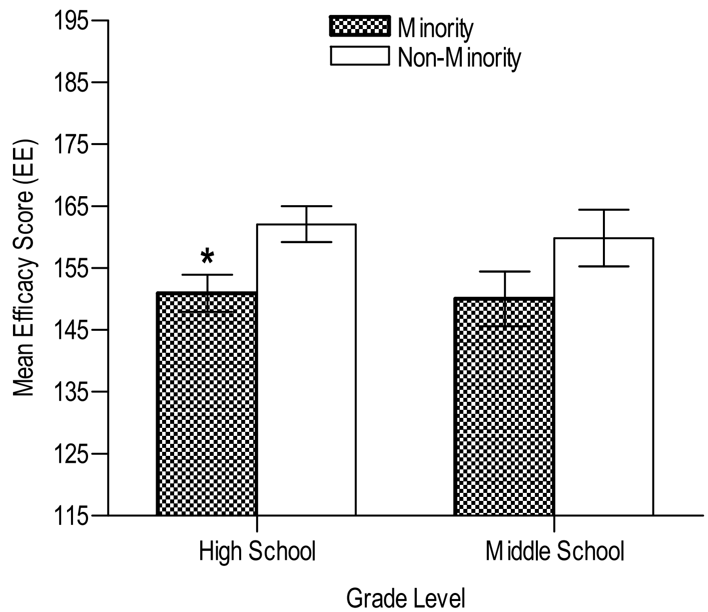

Figure 4-6. Effect of class ethnicity distribution (minority vs. non-minority) and grade level (high and middle school) on mean environmental science efficacy scores. Asterisks represent mean efficacy scores significantly lower (*p < 0.05) than paired group means. ***(High School CED minority n=14/CED non-minority n=12; Middle School CED minority n=8/CED non-minority n=6)***

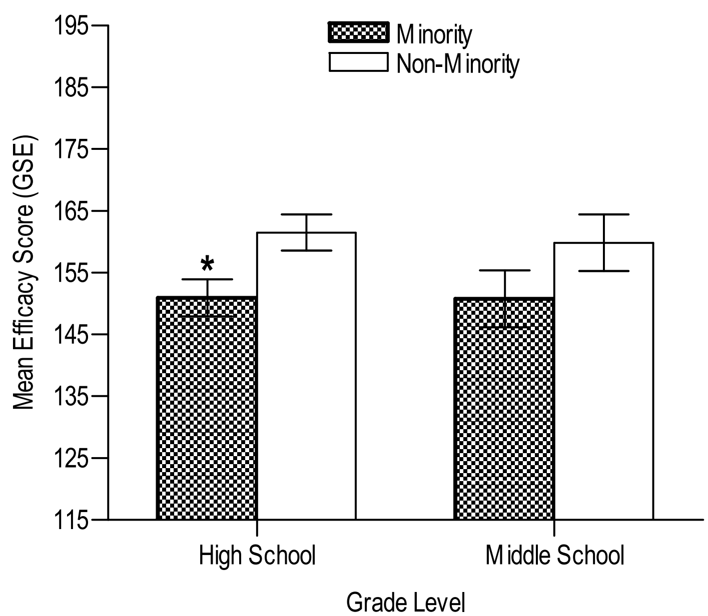

Figure 4-7. Effect of class ethnicity distribution (minority vs. non-minority) and grade level (high and middle school) on mean general science efficacy scores. Asterisks represent mean efficacy scores significantly lower (*p < 0.05) than paired group means. ***(High School CED minority n=14/CED non-minority n=12; Middle School CED minority n=8/CED non-minority n=6)***

Table 4-10. Two-way ANOVA: Effect of class ethnicity distribution and student grade level on instructor efficacy for environmental science.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	986.7	986.7	7.935	0.0078
Grade Level	1	22.63	22.63	0.182	0.6722
Interaction	1	3.911	3.911	0.03145	0.8602
Residual (error)	36	4477	124.4		
Total	39				

Table 4-11. Two-way ANOVA: Effect of class ethnicity distribution and student grade level on instructor efficacy for general science.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	865.3	865.3	6.855	0.0128
Grade Level	1	7.627	7.627	0.06042	0.8072
Interaction	1	4.96	4.96	0.0393	0.844
Residual (error)	36	4544	126.2		
Total	39				

Table 4-12. Summary of Bonferroni posttest for Table 4-10 two-way ANOVA.

Grade Level	Minority	Non-Minority	*p* value
High School	150.9	162.1	$p < 0.05$
Middle School	150	159.8	$p > 0.05$

Table 4-13. Summary of Bonferroni posttest for Table 4-11 two-way ANOVA.

Grade Level	Minority	Non-Minority	*p* value
High School	150.9	161.5	$p < 0.05$
Middle School	150.8	159.8	$p > 0.05$

Two-way ANOVA revealed that CED and efficacy dimensions had significant effects on mean level efficacy responses at both grade levels and science disciplines examined (Tables 4-14 and 4-15). For environmental science, effects were significant at $p < 0.001$ for both CED and efficacy dimension; for general science the effect of CED was not significant ($p > 0.05$), while the effect of efficacy dimension was significant at $p < 0.001$ (Tables 4-14 and 4-15). As indicated in Figures 4-8 and 4-9, mean efficacy dimension responses were consistently lower for instructors with high minority CED at both grade levels and science disciplines when compared to mean responses for instructors with high non-minority CED. Both high school (HS-) and middle school (mid-) science instructors' personal teaching efficacy (PTE) responses were highest, followed by classroom management (CM), student engagement (SE), and outcome expectancy (OE) respectively. Although mean responses for instructors with high minority CED were markedly lower than that of instructors with high non-minority CED, Bonferroni posttests found no statistically significant differences ($p > 0.05$) when comparing mean responses for instructors with contrasting CED; these results were consistent for both environmental and general science disciplines (Tables 4-16 and 4-17).

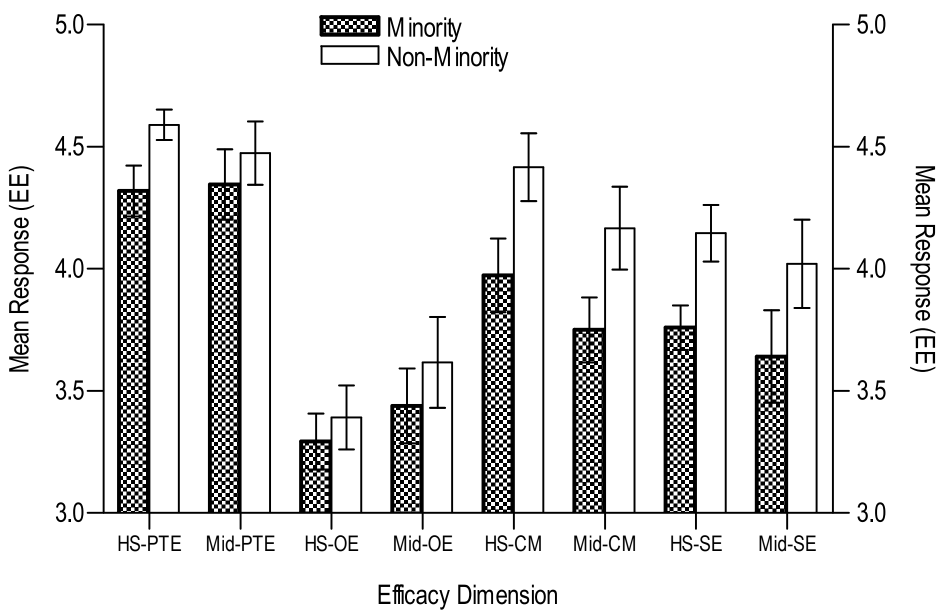

Figure 4-8. Effect of class ethnicity distribution (minority and non-minority) and efficacy dimension (personal teaching efficacy, outcome expectancy, classroom management, and student engagement) on high and middle school instructor mean environmental science efficacy response. *(High School CED minority n=14/CED non-minority n=12; Middle School CED minority n=8/CED non-minority n=6)*

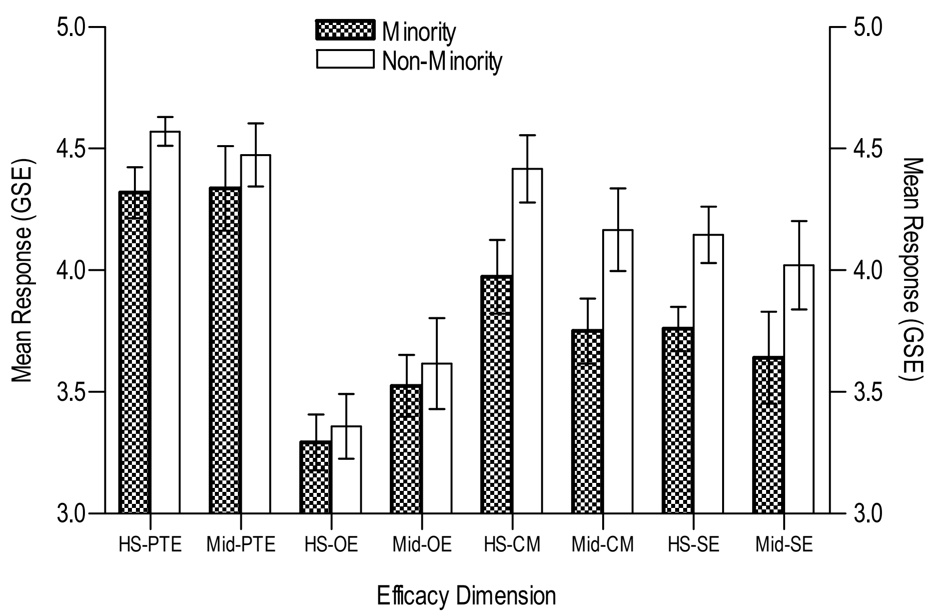

Figure 4-9. Effect of class ethnicity distribution (minority and non-minority) and efficacy dimension (personal teaching efficacy, outcome expectancy, classroom management, and student engagement) on high and middle school instructor mean general science efficacy response. *(High School CED minority n=14/CED non-minority n=12; Middle School CED minority n=8/CED non-minority n=6)*

Table 4-14. Two-way ANOVA: Effect of class ethnicity distribution and efficacy dimension environmental efficacy.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	2.974	2.974	16.45	$p < 0.0001$
Efficacy Dimension	7	23.18	3.311	18.31	$p < 0.0001$
Interaction	7	0.666	0.09514	0.5263	0.8136
Residual (error)	144	26.03	0.1808		
Total	159				

Table 4-15. Two-way ANOVA: Effect of class ethnicity distribution and efficacy dimension on general science efficacy.

Source of Variation	Df	SS	MS	F	*p* value
Class Ethnicity Distribution	1	2.647	2.647	14.56	0.0002
Efficacy Dimension	7	22.92	3.274	18.01	$p < 0.0001$
Interaction	7	0.8378	0.1197	0.6583	0.707
Residual (error)	144	26.18	0.1818		
Total	159				

Table 4-16. Summary of Bonferroni posttest for Table 4-14 two-way ANOVA.

Efficacy Dimension	Minority	Non-Minority	t	*p* value
HS-PTE	4.319	4.59	1.621	$p > 0.05$
Mid-PTE	4.346	4.474	0.5583	$p > 0.05$
HS-OE	3.293	3.392	0.5907	$p > 0.05$
Mid-OE	3.438	3.617	0.7803	$p > 0.05$
HS-CM	3.973	4.417	2.651	$p > 0.05$
Mid-CM	3.75	4.167	1.815	$p > 0.05$
HS-SE	3.759	4.146	2.313	$p > 0.05$
Mid-SE	3.641	4.021	1.656	$p > 0.05$

Table 4-17. Summary of Bonferroni posttest for Table 4-15 two-way ANOVA.

Efficacy Dimension	Minority	Non-Minority	t	*p* value
HS-PTE	4.319	4.571	1.501	$p > 0.05$
Mid-PTE	4.337	4.474	0.5985	$p > 0.05$
HS-OE	3.293	3.358	0.3903	$p > 0.05$
Mid-OE	3.525	3.617	0.3981	$p > 0.05$
HS-CM	3.973	4.417	2.644	$p > 0.05$
Mid-CM	3.75	4.167	1.809	$p > 0.05$
HS-SE	3.759	4.146	2.306	$p > 0.05$
Mid-SE	3.641	4.021	1.651	$p > 0.05$

High school instructors with high minority CED exhibited high mean HS-PTE responses; responses declined for HS-CM, HS-SE, and HS-OE respectively. Within high minority classrooms, instructors' HS-PTE responses were significantly higher than both HS-OE ($p < 0.001$) and HS-SE ($p < 0.01$), HS-OE was significantly lower than both HS-CM ($p < 0.001$) and HS-SE ($p < 0.01$), there was not a significant difference ($p > 0.05$) when comparing HS-SE and HS-CM or HS-PTE and HS-CM. When mean responses for only high school instructors with high non-minority CED were compared, results were consistent with that of high school instructors with high minority CED with the exception of *p* values; HS-PTE and HS-SE differed at a $p < 0.05$ level and HS-OE and HS-SE differed at a $p < 0.001$ level. Additionally, results were consistent for both environmental and general science disciplines (Tables 4-18 and 4-19).

When comparing only mean responses for middle school instructors with high minority CED, instructors exhibited high efficacy responses for mid-PTE; responses declined for mid-CM, mid-SE, and mid-OE respectively (Tables 4-18 and 4-19). Within minority classrooms, mid-PTE responses were significantly higher than mid-CM ($p < 0.05$), mid-SE ($p < 0.01$), and mid-OE ($p < 0.001$); there was not a statistically significant difference ($p < 0.05$) in mean responses for mid-CM, mid-SE, or mid-OE (Tables 4-18 and 4-19). Comparisons between only middle school instructors with high percent non-minority CED revealed that instructors were most efficacious in mean mid-PTE responses and declined for mid-CM, mid-SE, and mid-OE, respectively. However, mid-PTE was not found to be statistically different ($p > 0.05$) from mid-CM or mid-SE; mean responses for mid-PTE were significantly higher ($p < 0.001$) than that of mid-OE. A statistically significant difference ($p > 0.05$) was not evident upon comparison of mean responses for mid-CM, mid-SE, or mid-OE. These data were consistent for both environmental and general science disciplines (Tables 4-18 and 4-19).

Comparison of mean efficacy response for middle and high school instructors with contrasting CED revealed that mean mid-PTE responses were slightly higher than that of HS-PTE responses when comparing only instructors with high minority CED. Instructors with high non-minority CED exhibited somewhat higher mean HS-PTE than that of mid-PTE. Mean mid-OE response was considerably higher than that of HS-OE response for instructors with either minority or non-minority CED. Mean HS-CM responses were considerably higher than mean mid-CM responses for instructors with either high minority or non-minority CED. Lastly, mean HS-SE responses were higher than that of mid-SE responses; results were consistent upon examination of either instructors of high minority or high non-minority CED. Values higher than compared group were not considered statistically significant as indicated in two-way ANOVA posttests for CED and efficacy dimension for both EE and GSE (Figures 4-8 and 4-9; Tables 4-18 and 4-19).

Table 4-18. Summary of Bonferroni posttest for two-way ANOVA of efficacy dimension and class ethnicity distribution for the environmental science discipline.

Class Ethnicity Distribution	HS-PTE	HS-OE	t	*p* value
Minority	4.319	3.293	6.383	$p < 0.001$
Non-Minority	4.59	3.392	6.902	$p < 0.001$
	HS-PTE	**HS-CM**	**t**	***p* value**
Minority	4.319	3.973	2.15	$p > 0.05$
Non-Minority	4.59	4.417	0.9971	$p > 0.05$
	HS-PTE	**HS-SE**	**t**	***p* value**
Minority	4.319	3.759	3.483	$p < 0.01$
Non-Minority	4.59	4.146	2.557	$p > 0.05$

	HS-PTE	Mid-PTE	t	*p* value
Minority	4.319	4.346	0.1458	$p > 0.05$
Non-Minority	4.59	4.474	0.5427	$p > 0.05$
	HS-OE	**HS-CM**	**t**	***p* value**
Minority	3.293	3.973	4.234	$p < 0.001$
Non-Minority	3.392	4.417	5.905	$p < 0.001$
	HS-OE	**HS-SE**	**t**	***p* value**
Minority	3.293	3.759	2.9	$p < 0.01$
Non-Minority	3.392	4.146	4.345	$p < 0.001$
	HS-OE	**Mid-OE**	**t**	***p* value**
Minority	3.293	3.438	0.7676	$p > 0.05$
Non-Minority	3.392	3.617	1.058	$p > 0.05$
	HS-CM	**HS-SE**	**t**	***p* value**
Minority	3.973	3.759	1.333	$p > 0.05$
Non-Minority	4.417	4.146	1.56	$p > 0.05$
	HS-CM	**Mid-CM**	**t**	***p* value**
Minority	3.973	3.75	1.185	$p > 0.05$
Non-Minority	4.417	4.167	1.176	$p > 0.05$
	HS-SE	**Mid-SE**	**t**	***p* value**
Minority	3.759	3.641	0.6278	$p > 0.05$
Non-Minority	4.146	4.021	0.588	$p > 0.05$

	Mid-PTE	Mid-OE	t	*p* value
Minority	4.346	3.438	4.274	$p < 0.001$
Non-Minority	4.474	3.617	3.494	$p < 0.01$

	Mid-PTE	Mid-CM	t	*p* value
Minority	4.346	3.75	2.804	$p > 0.05$
Non-Minority	4.474	4.167	1.253	$p > 0.05$

	Mid-PTE	Mid-SE	t	*p* value
Minority	4.346	3.641	3.319	$p < 0.01$
Non-Minority	4.474	4.021	1.848	$p > 0.05$

	Mid-OE	Mid-CM	t	*p* value
Minority	3.438	3.75	1.47	$p > 0.05$
Non-Minority	3.617	4.167	2.241	$p > 0.05$

	Mid-OE	Mid-SE	t	*p* value
Minority	3.438	3.641	0.9555	$p > 0.05$
Non-Minority	3.617	4.021	1.646	$p > 0.05$

	Mid-CM	Mid-SE	t	*p* value
Minority	3.75	3.641	0.5145	$p > 0.05$
Non-Minority	4.167	4.021	0.5941	$p > 0.05$

Table 4-19. Summary of Bonferroni posttest for two-way ANOVA of efficacy dimension and class ethnicity distribution for the general science discipline.

Class Ethnicity Distribution	HS-PTE	HS-OE	t	*p* value
Minority	4.319	3.293	6.365	$p < 0.001$
Non-Minority	4.571	3.358	6.963	$p < 0.001$
	HS-PTE	**HS-CM**	**t**	***p* value**
Minority	4.319	3.973	2.144	$p > 0.05$
Non-Minority	4.571	4.417	0.8838	$p > 0.05$
	HS-PTE	**HS-SE**	**t**	***p* value**
Minority	4.319	3.759	3.473	$p < 0.01$
Non-Minority	4.571	4.146	2.44	$p > 0.05$
	HS-PTE	**Mid-PTE**	**t**	***p* value**
Minority	4.319	4.337	0.09449	$p > 0.05$
Non-Minority	4.571	4.474	0.451	$p > 0.05$
	HS-OE	**HS-CM**	**t**	***p* value**
Minority	3.293	3.973	4.221	$p < 0.001$
Non-Minority	3.358	4.417	6.08	$p < 0.001$
	HS-OE	**HS-SE**	**t**	***p* value**
Minority	3.293	3.759	2.892	$p < 0.01$
Non-Minority	3.358	4.146	4.524	$p < 0.001$
	HS-OE	**Mid-OE**	**t**	***p* value**
Minority	3.293	3.525	1.228	$p > 0.05$
Non-Minority	3.358	3.617	1.212	$p > 0.05$

	HS-CM	HS-SE	t	*p* value
Minority	3.973	3.759	1.33	$p > 0.05$
Non-Minority	4.417	4.146	1.556	$p > 0.05$

	HS-CM	Mid-CM	t	*p* value
Minority	3.973	3.75	1.181	$p > 0.05$
Non-Minority	4.417	4.167	1.173	$p > 0.05$

	HS-SE	Mid-SE	t	*p* value
Minority	3.759	3.641	0.626	$p > 0.05$
Non-Minority	4.146	4.021	0.5863	$p > 0.05$

	Mid-PTE	Mid-OE	t	*p* value
Minority	4.337	3.525	3.806	$p < 0.001$
Non-Minority	4.474	3.617	3.484	$p < 0.01$

	Mid-PTE	Mid-CM	t	*p* value
Minority	4.337	3.75	2.751	$p > 0.05$
Non-Minority	4.474	4.167	1.25	$p > 0.05$

	Mid-PTE	Mid-SE	t	*p* value
Minority	4.337	3.641	3.264	$p < 0.01$
Non-Minority	4.474	4.021	1.842	$p > 0.05$

	Mid-OE	Mid-CM	t	*p* value
Minority	3.525	3.75	1.055	$p > 0.05$
Non-Minority	3.617	4.167	2.234	$p > 0.05$

	Mid-OE	Mid-SE	t	*p* value
Minority	3.525	3.641	0.5423	$p > 0.05$
Non-Minority	3.617	4.021	1.642	$p > 0.05$
	Mid-CM	**Mid-SE**	**t**	***p* value**
Minority	3.75	3.641	0.513	$p > 0.05$
Non-Minority	4.167	4.021	0.5924	$p > 0.05$

Two-way ANOVA of grade level and science discipline revealed that neither grade level nor science discipline had a significant effect ($p > 0.05$) on mean efficacy scores (Table 4-20). However, two-way ANOVA of grade level and efficacy dimension revealed that efficacy dimension had a significant effect ($p < 0.0001$) on mean responses; the effect of grade level was not considered significant ($p > 0.05$) (Table 4-21). When examining the effect of efficacy dimension, posttests revealed (Table 4-22) that mean efficacy responses for HS-PTE were significantly higher than mean responses for HS-OE ($p < 0.001$) and HS-SE ($p < 0.001$); mean HS-CM responses were not significantly different ($p > 0.05$) from mean HS-PTE response. Mean efficacy responses for mid-PTE were significantly higher than that of mid-OE ($p < 0.001$), mid-CM ($p < 0.05$), and mid-SE responses ($p < 0.001$). When comparing mid-OE and mid-CM, mid-OE for EE was significantly lower ($p < 0.05$) when compared with mid-CM for EE; mid-OE for GSE and mid-CM for GSE were not considered significantly different ($p > 0.05$). Other than the previous, results were consistent for both environmental and general science.

Table 4-20. **Two-way ANOVA: Effect of grade level and science discipline on mean instructor efficacy scores.**

Source of Variation	DS	SS	MS	F	*p* value
Grade Level	1	41.7	41.7	0.284	0.5957
Science Discipline	1	0.1155	0.1155	0.0007866	0.9777
Interaction	1	2.216	2.216	0.01509	0.9026
Residual (error)	76	11160	146.9		
Total	79				

Table 4-21. **Two-way ANOVA: Effect of grade level and efficacy dimension on mean instructor efficacy responses.**

Source of Variation	DF	SS	MS	F	*p* value
Grade Level	1	0.2117	0.2117	1.071	0.3016
Efficacy Dimension	7	36.54	5.22	26.4	$p < 0.0001$
Interaction	7	2.087	0.2982	1.508	0.1638
Residual (error)	304	60.11	0.1977		
Total	319				

Table 4-22. **Summary of Bonferroni posttest for two-way ANOVA of efficacy dimension and grade level.**

Grade Level	EE-PTE	EE-OE	t	*p* value
High School	4.444	3.338	8.963	$p < 0.001$
Middle School	4.401	3.514	5.277	$p < 0.001$
	EE-PTE	**EE-CM**	**t**	***p* value**
High School	4.444	4.178	2.156	$p > 0.05$
Middle School	4.401	3.929	2.812	$p > 0.05$

	EE-PTE	EE-SE	t	*p* value
High School	4.444	3.938	4.105	$p < 0.001$
Middle School	4.401	3.804	3.555	$p < 0.001$

	EE-PTE	GS-PTE	t	*p* value
High School	4.444	4.435	0.07197	$p > 0.05$
Middle School	4.401	4.396	0.03269	$p > 0.05$

	EE-OE	EE-CM	t	*p* value
High School	3.338	4.178	6.806	$p < 0.001$
Middle School	3.514	3.929	2.465	$p > 0.05$

	EE-OE	EE-SE	t	*p* value
High School	3.338	3.938	4.857	$p < 0.001$
Middle School	3.514	3.804	1.721	$p > 0.05$

	EE-OE	GS-OE	t	*p* value
High School	3.338	3.323	0.1247	$p > 0.05$
Middle School	3.514	3.564	0.2975	$p > 0.05$

	EE-CM	EE-SE	t	*p* value
High School	4.178	3.938	1.949	$p > 0.05$
Middle School	3.929	3.804	0.7438	$p > 0.05$

	EE-CM	GS-CM	t	*p* value
High School	4.178	4.178	0	$p > 0.05$
Middle School	3.929	3.929	0	$p > 0.05$

	EE-SE	**GS-SE**	**t**	***p* value**
High School	3.938	3.938	0	$p > 0.05$
Middle School	3.804	3.804	0	$p > 0.05$

	GS-PTE	**GS-OE**	**t**	***p* value**
High School	4.435	3.323	9.015	$p < 0.001$
Middle School	4.396	3.564	4.946	$p < 0.001$

	GS-PTE	**GS-CM**	**t**	***p* value**
High School	4.435	4.178	2.084	$p > 0.05$
Middle School	4.396	3.929	2.779	$p > 0.05$

	GS-PTE	**GS-SE**	**t**	***p* value**
High School	4.435	3.938	4.033	$p < 0.001$
Middle School	4.396	3.804	3.523	$p < 0.001$

	GS-OE	**GS-CM**	**t**	***p* value**
High School	3.323	4.178	6.931	$p < 0.001$
Middle School	3.564	3.929	2.168	$p > 0.05$

	GS-OE	**GS-SE**	**t**	***p* value**
High School	3.323	3.938	4.982	$p < 0.001$
Middle School	3.564	3.804	1.424	$p > 0.05$

	GS-CM	**GS-SE**	**t**	***p* value**
High School	4.178	3.938	1.949	$p > 0.05$
Middle School	3.929	3.804	0.7438	$p > 0.05$

Finally, as indicated in Figure 4-10, mean HS-PTE response was higher than that of mid-PTE. However, mid-OE was considerably higher than that of HS-OE. Both HS-CM and HS-SE were higher than that of mid-CM and mid-SE. Although a significant effect was indicated and considerable variations in mean responses could be identified, Bonferroni posttests of individual comparisons did not detect any statistically significant differences ($p > 0.05$) between high school and middle school efficacy dimensions.

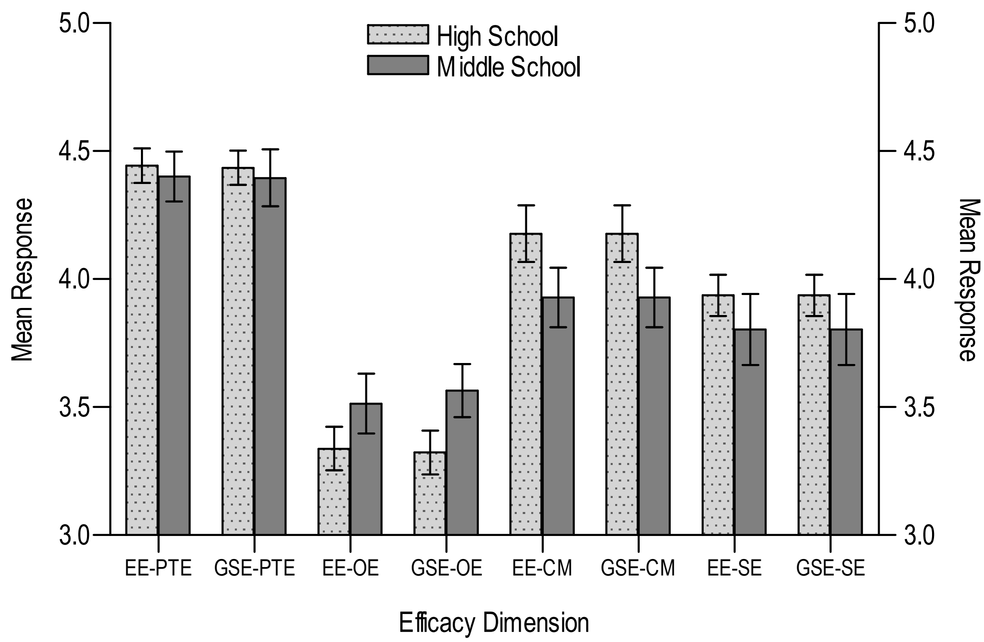

Figure 4-10. Effect of grade level (high *n=26* vs. middle *n=14* school) and efficacy dimension (personal teaching efficacy, outcome expectancy, classroom management, and student engagement) on mean environmental and general science efficacy responses.

IV. RESEARCH QUESTION: Does instructor gender (male vs. female) affect mean environmental and general science efficacy scores of instructors with contrasting class ethnicity distributions (minority vs. non-minority?

As indicated in Figure 4-11, male instructors with high minority CED exhibited markedly lower efficacy levels than that of female instructors with high minority CED. There was not a drastic difference between efficacy scores when comparing male and female instructors with high non-minority CED, even though female efficacy remained diminutively higher. Consequently, when comparing contrasting CED, male efficacy scores were consistently lower than female efficacy scores; however, as indicated in Table 4-23, two-way ANOVA of instructor gender and CED revealed that only the effect of CED was significant ($p < 0.0001$); the effect of instructor gender was not considered significant ($p > 0.05$).

As indicated in Figure 4-12, efficacy scores for both environmental and general science were consistently lower for male instructors with high minority CED when compared with male instructors with high non-minority CED, although posttests only revealed a statistically significant difference for male instructor EE ($p < 0.05$) when comparing contrasting CED (Table 4-24). Efficacy scores for female instructors with high minority CED were consistently lower than that of female instructors with high non-minority CED; posttests indicated that these differences were not considered significantly different ($p > 0.05$).

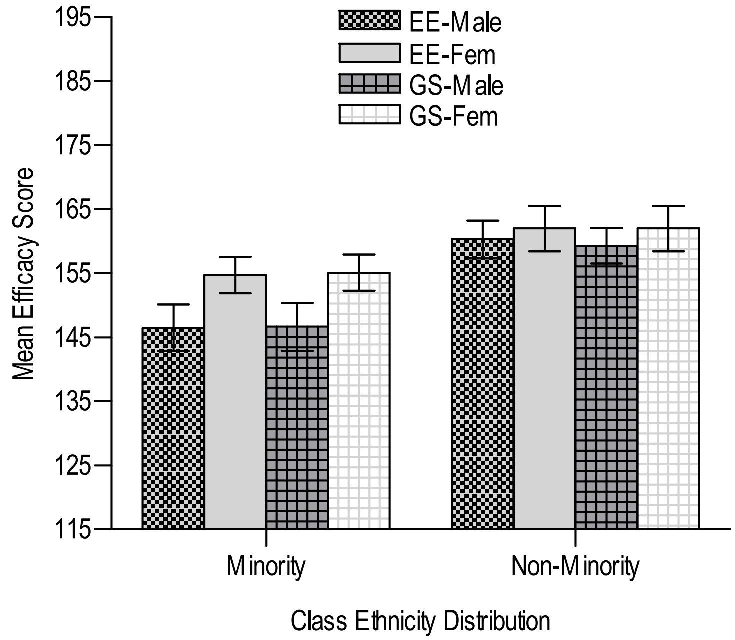

Figure 4-11. Effect of instructor gender (male vs. female) and class ethnicity distribution (minority vs. non-minority) on mean environmental and general science efficacy scores. ***(Male CED minority n=11/CED non-minority n=7; Female CED minority n=11/CED non-minority n=11)***

Table 4-23. Two-way ANOVA: Effect of instructor gender and class ethnicity distribution on mean environmental and general science efficacy scores.

Source of Variation	DF	SS	MS	F	*p* value
Instructor Gender	3	540.3	180.1	1.573	0.2034
Class Ethnicity Distribution	1	1989	1989	17.38	$p < 0.0001$
Interaction	3	185.3	61.78	0.5396	0.6567
Residual (error)	72	8243	114.5		
Total	79				

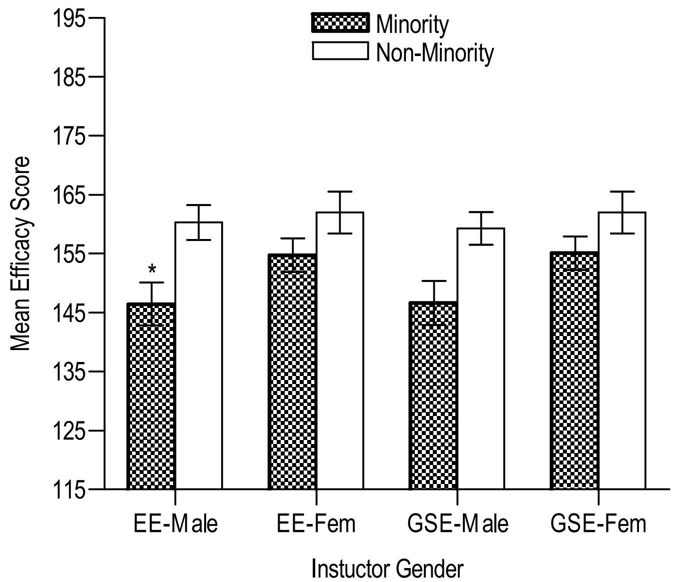

Figure 4-12. Effect of class ethnicity distribution (minority vs. non-minority) and instructor gender (male vs. female) on mean environmental and general science efficacy scores. Asterisks represent mean efficacy scores significantly lower (*$p < 0.05$) than paired group means. ***(Male CED minority n=11/CED non-minority n=7; Female CED minority n=11/CED non-minority n=11)***

Table 4-24. Summary of Bonferroni posttest for two-way ANOVA examining effect of class ethnicity distribution and instructor gender on mean efficacy scores for environmental and general science.

Instructor Gender	Minority	Non-Minority	t	*p* value
EE-Male	146.5	160.3	2.674	$p < 0.05$
EE-Fem	154.7	162	1.594	$p > 0.05$
GSE-Male	146.6	159.3	2.445	$p > 0.05$
GSE-Fem	155.1	162	1.514	$p > 0.05$

Two-way ANOVA of instructor gender and efficacy dimension revealed a significant interaction of both factors on mean efficacy responses (Table 4-25). Male instructor mean OE, CM, and SE responses were markedly lower than female instructor mean responses; however, male instructor mean PTE responses were higher than that of female instructor mean PTE responses (Figure 4-13). Although differences in the above group means comparisons are evident, posttests only indicated that male instructor CM responses were statistically lower ($p < 0.001$) than female instructor CM responses; no other group comparisons were statistically different ($p < 0.05$) (Table 4-26).

Table 4-25. Two-way ANOVA: Effect of instructor gender and efficacy dimension on environmental and general science efficacy responses.

Source of Variation	DF	SS	MS	F	*p* value
Instructor Gender	1	3.54	3.54	19.39	$p < 0.0001$
Efficacy Dimension	7	43.26	6.181	33.85	$p < 0.0001$
Interaction	7	3.359	0.4798	2.628	0.0119
Residual (error)	304	55.51	0.1826		
Total	319				

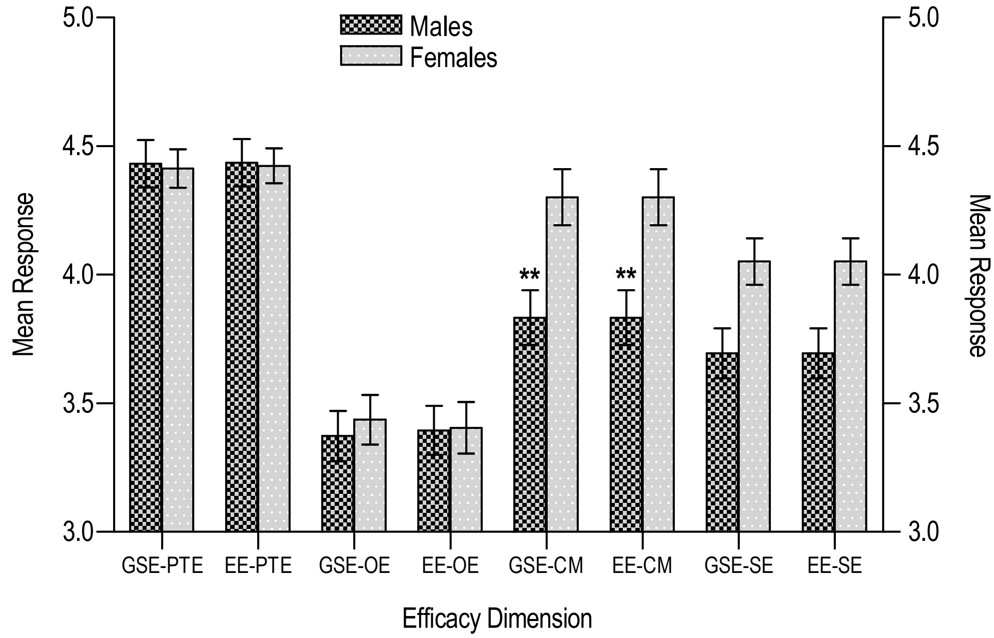

Figure 4-13. Effect of instructor gender (male *n=18* vs. female *n=22*) and efficacy dimension (personal teaching efficacy, outcome expectancy, classroom management, and student engagement) on mean environmental and general science efficacy responses. Asterisks represent mean efficacy scores significantly lower ($p < 0.01$) than paired group means.**

Table 4-26. Summary of Bonferroni posttest for Table 4-25 two-way ANOVA.

Efficacy Dimension	Males	Females	t	*p* value
GSE-PTE	4.432	4.413	0.1402	$p > 0.05$
EE-PTE	4.436	4.423	0.0944	$p > 0.05$
GS-OE	3.372	3.436	0.4723	$p > 0.05$
EE-OE	3.394	3.405	0.07438	$p > 0.05$
GSE-CM	3.833	4.301	3.445	$p < 0.01$
EE-CM	3.833	4.301	3.445	$p < 0.01$
GSE-SE	3.694	4.051	2.626	$p > 0.05$
EE-SE	3.694	4.051	2.626	p > 0.05

V. RESEARCH QUESTION: What are the attitudes among instructors on practical applications for environmental instruction? Is there a difference in attitudes when comparing science instructors with contrasting class ethnicity distributions (minority vs. non-minority)?

When assessing the extent of outdoor classroom utilization to reinforce science learning, both high minority and non-minority CED instructors disagreed with this assertion, thus exhibiting relatively low responses. Although high non-minority CED instructors exhibited slightly higher mean responses than that of instructors with high minority CED, t-test did not reveal a statistically significant difference ($p > 0.05$) in mean responses (Table 4-27).

Two-way ANOVA revealed a significant interaction between CED and instructor gender on mean response for the extent they utilize outdoor classrooms to reinforce science learning (Table 4-28; Figure 4-14). Posttest revealed that males with high minority CED did not utilize an outdoor classroom as often as males with high non-minority CED; males with high minority CED exhibited significantly lower mean responses ($p < 0.05$) (Table 4-29; Figure 4-14). Females with high minority CED utilized an outdoor classroom to reinforce science learning slightly more than female instructors with high non-minority CED, although these differences were not considered statistically significant ($p > 0.05$) (Table 4-29; Figure 4-14).

There was not a significant difference ($p > 0.05$) between mean responses of instructors having greater or less than ten years experience as indicated by t-tests (Table 4-30). While instructors having greater than ten years experience exhibited slightly higher mean responses, both experience levels disagreed with the above assertion that they often utilize an outdoor classroom to reinforce science learning. Additionally, when the effect of CED and instructors' years experience teaching on outdoor classroom utilization was assessed, there was not an effect of either factor as revealed by two-way ANOVA (Table 4-31; Figure 4-15).

Table 4-27. Two tailed t-test: Classroom ethnicity distribution's effect on the extent instructors utilize outdoor classrooms

Group	*n*	M	SD	*p*	95%CI
Minority	22	2.455	1.101	0.2373	-1.167 to 0.2983
Non-Minority	18	2.889	1.183		

Table 4-28. Two-way ANOVA: Effect of instructor gender and class ethnicity distribution on the extent instructors utilize outdoor classrooms

Source of Variation	DF	SS	MS	F	*p* value
Instructor Gender	1	3.002	3.002	2.503	0.1224
Class Ethnicity Distribution	1	1.365	1.365	1.139	0.2931
Interaction	1	5.274	5.274	4.398	0.0431
Residual (error)	36	43.17	1.199		
Total	39				

Table 4-29. Bonferroni posttest of Table 4-27 two-way ANOVA.

Class Ethnicity Distribution	Minority	Non-minority	t	*p* value
Male	2.273	3.571	2.453	$p < 0.05$
Female	2.636	2.455	0.3894	$p > 0.05$

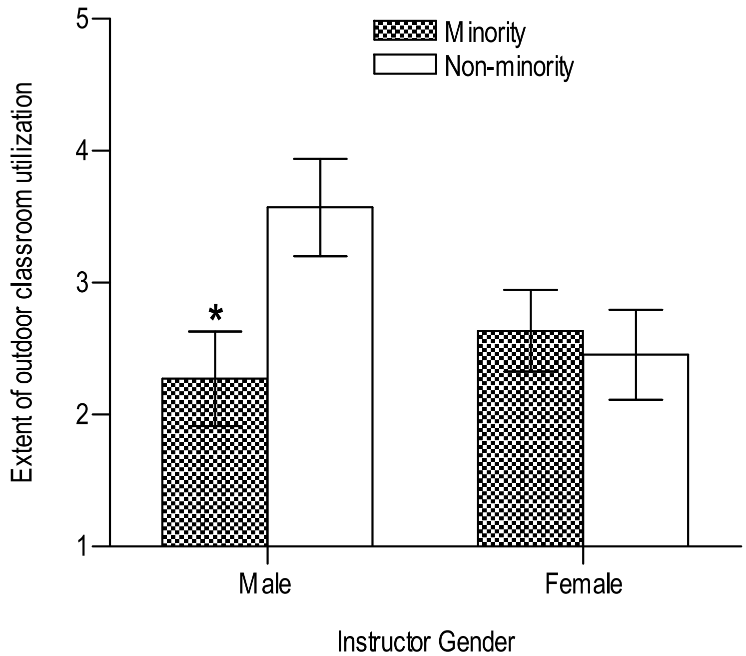

Figure 4-14. Effect of instructor gender (male vs. female) and class ethnicity distribution (minority vs. non-minority) on the extent instructors utilize outdoor classrooms. Asterisks represent mean efficacy scores significantly lower (p < 0.05) than paired group means. *(Male CED minority n=11/CED non-minority n=7; Female CED minority n=11/CED non-minority n=11)***

Table 4-30. Two tailed t-test: Effect of years teaching experience on the extent instructors utilize outdoor classrooms

Group	*n*	M	SD	*p*	95%CI
10 yrs (+)	17	2.765	1.147	0.5924	-0.5488 to 0.9478
10 yrs (-)	23	2.565	1.161		

Table 4-31. Two-way ANOVA: Effect of class ethnicity distribution and years teaching experience on the extent instructors utilize outdoor classrooms

Source of Variation	DF	SS	MS	F	*p* value
Class Ethnicity Distribution	1	1.331	1.331	1.012	0.3212
Years Experience	1	0.2136	0.2136	0.1623	0.6894
Interaction	1	1.538	1.538	1.169	0.2868
Residual (error)	36	47.36	1.316		
Total	39				

Figure 4-15. Effect of classroom ethnicity distribution and years teaching experience on the extent instructors utilize outdoor classrooms. ***[10 Yrs(+) CED minority n=9/CED non-minority n=8; 10Yrs(-) CED minority n=13/CED non-minority n=10]***

VI. Research Question: Do variations exist among science instructors' extent of, and willingness to, utilize practical environmental instruction when comparing instructors with contrasting class ethnicity distributions?

When assessing instructors' willingness to utilize an outdoor classroom, both minority and non-minority CED instructors agreed that they would be willing to utilize an outdoor classroom to reinforce science learning and thus exhibited relatively high responses. Although high minority CED instructors exhibited slightly higher mean responses than that of instructors with high non-minority CED, t-test did not reveal a statistically significant difference ($p < 0.05$) in mean responses (Table 4-32).

When the effect of CED and instructor gender on willingness to utilize an outdoor classroom to reinforce science learning was examined, two-way ANOVA revealed that there was not a significant effect from these factors (Table 4-33). However, both male and female instructors agreed with the assertion that they would be willing to utilize outdoor classrooms; male responses were relatively the same for both minority and non-minority CED, however, females with high minority CED were slightly more willing to utilize outdoor classrooms (Figure 4-16). Consequently, posttests did not reveal a significant difference ($p > 0.05$) in mean responses for male or females with minority or non-minority CED.

There was a significant difference ($p < 0.05$) between mean responses of instructors having greater or less than ten years experience as indicated by t-tests (Table 4-34) with regard to willingness to utilize outdoor classrooms to reinforce science learning. While both experience levels agreed to the above assertion, instructors having less than ten years experience exhibited significantly higher ($p < 0.01$) mean responses than that of instructors having greater than ten years experience (Figure 4-17). Additionally, when the effect of instructor's years experience and

CED on the above assertion were examined, two-way ANOVA revealed that the effect of years experience was significant (Table 4-35); there was not a significant effect from CED. Instructors having less than 10 years teaching experience with high minority CED were more willing to implement outdoor education than instructors with greater than 10 years teaching experience with high minority CED (Figure 4-18); these results were consistent for high non-minority CED as well. Posttests only revealed a statistical difference when comparing years experience and non-minority classrooms (Table 4-36).

Table 4-32. Two tailed t-test: Classroom ethnicity distribution's effect on instructors' willingness to utilize outdoor classrooms to reinforce science learning.

Group	*n*	M	SD	*p*	95%CI
Minority	22	4.5	0.5976	0.5643	-0.2765 to 0.4987
Non-Minority	18	4.389	0.6077		

Table 4-33. Two-way ANOVA: Effect of class ethnicity distribution and gender on instructors' willingness to utilize outdoor classrooms to reinforce science learning.

Source of Variation	DF	SS	MS	F	*p* value
Class Ethnicity Distribution	1	0.05844	0.05844	0.1576	0.6937
Instructor Gender	1	0.3653	0.3653	0.9849	0.3276
Interaction	1	0.1039	0.1039	0.2802	0.5998
Residual (error)	36	13.35	0.3709		
Total	39				

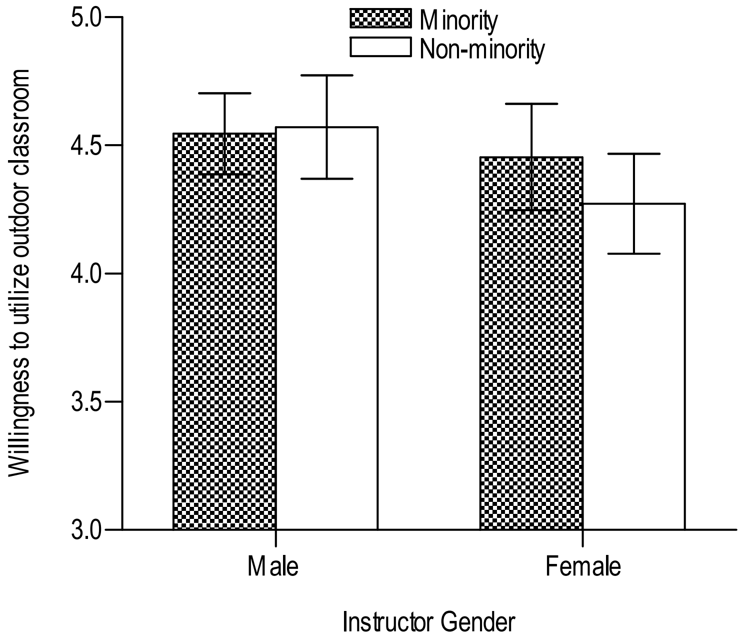

Figure 4-16. Effect of class ethnicity distribution (minority vs. non-minority) and instructor gender (male vs. female) on instructors' willingness to utilize outdoor classrooms to reinforce science learning. *(Male CED minority n=11/CED non-minority n=7; Female CED minority n=11/CED non-minority n=11)*

Table 4-34. Two tailed t-test: Effect of years teaching experience on instructors' willingness to utilize outdoor classrooms to reinforce science learning.

Group	*n*	M	SD	*p*	95%CI
10 Yrs (+)	17	4.118	0.6002	0.0015	-0.9207 to -0.2353
10 Yrs (-)	23	4.696	0.4705		

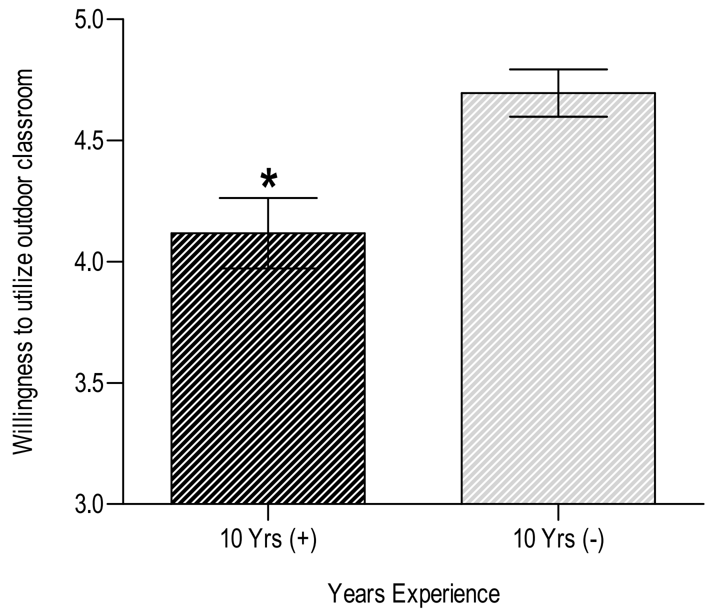

Figure 4-17. Effect of years experience teaching on instructors' willingness to utilize outdoor classrooms to reinforce science learning. Asterisks represent mean efficacy scores significantly lower (***p*** **< 0.01) than paired group means. [*10Yrs (+) n=17; 10Yrs (-) n=23]***

Table 4-35. Two-way ANOVA: Effect of years teaching experience and class ethnicity distribution on instructors' willingness to utilize outdoor classrooms to reinforce science learning.

Source of Variation	**DF**	**SS**	**MS**	**F**	***p* value**
Years Experience	1	3.315	3.315	11.45	0.0017
Class Ethnicity Distribution	1	0.1114	0.1114	0.3848	0.539
Interaction	1	0.128	0.128	0.442	0.5104
Residual (error)	36	10.42	0.2896		
Total	39				

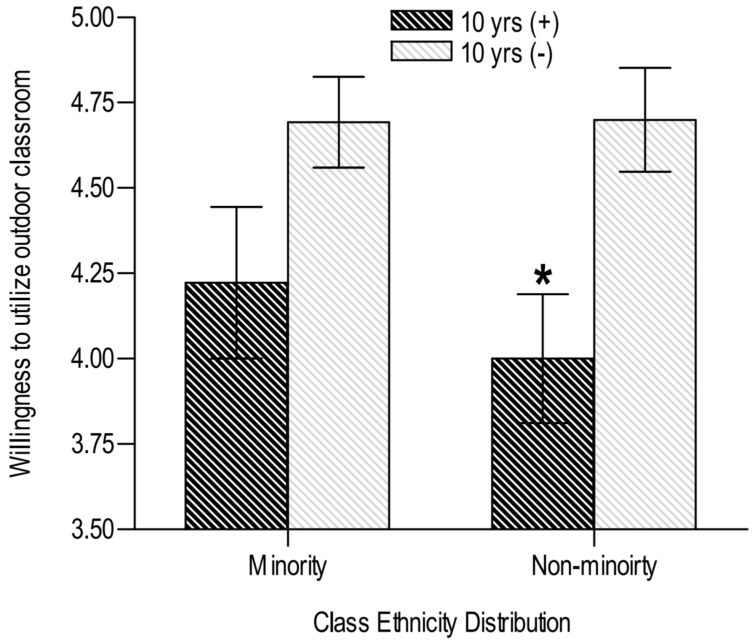

Figure 4-18. Effect of years experience teaching and class ethnicity distribution (minority vs. non-minority) on instructors' willingness to utilize outdoor classrooms to reinforce science learning. Asterisks represent mean efficacy scores significantly lower (*$p < 0.05$) than paired group means. ***[10 Yrs(+) CED minority n=9/CED non-minority n=8; 10Yrs(-) CED minority n=13/CED non-minority n=10]***

Table 4-36. Bonferroni posttest of Table 4-34 two-way ANOVA.

Class Ethnicity Distribution	10 yrs (+)	10 yrs (-)	t	*p* value
Minority	4.222	4.692	2.015	$p > 0.05$
Non-Minority	4	4.7	2.742	$p < 0.05$

CHAPTER V

SUMMARY, DISCUSSION, AND IMPLICATIONS

Summary of Results

Major findings presented here conclude that science teacher efficacy was markedly lower for science instructors with high minority class ethnicity distribution (CED) when compared to efficacy levels of instructors with high non-minority CED. Additionally, when examining efficacy dimensions separately, markedly lower mean efficacy dimension responses were consistent for instructors with high minority CED; however, only classroom management (CM) and student engagement (SE) were considered statistically different as indicated in Figure 4-2. Results were consistent for both the environmental and general science disciplines. When comparing environmental efficacy and general science efficacy, there was not a significant difference among total efficacy levels or mean efficacy dimension responses. Science instructors having greater than 10 years teaching experience exhibited markedly higher efficacy scores than that of instructors having less than ten years experience (Figure 4-4), although both experience levels exhibited markedly lower efficacy when CED was high minority. Both high and middle school science instructors exhibited markedly lower efficacy when CED was high minority. Consequently, when examining mean efficacy dimension responses middle school science instructors' overall mean outcome expectancy (OE) responses were higher than that of high school science instructors, while personal teacher efficacy (PTE), CM, and SE responses were higher for high school instructors. When comparing overall efficacy dimension, females showed markedly higher mean CM, SE, and OE responses; female PTE was slightly lower than that of male PTE.

Neither instructors of high minority or high non-minority students agreed with the assertion that an outdoor classroom was being utilized to reinforce science learning. Consequently, male instructor responses to outdoor classroom utilization were statistically lower for instructors with high minority CED when compared to male instructors with high non-minority CED (Figure 4-14). Female responses, though not statistically significant, were higher for instructors with high minority CED, when compared to that of high non-minority CED. When examining the above assertion according to years teaching experience and CED, instructors having less than ten years experience and high minority CED utilized an outdoor classroom less than instructors of this experience level with high non-minority CED (Figure 4-15).

When assessing instructors' willingness to utilize outdoor classrooms according to gender and CED, males were slightly more willing than females to utilize outdoor classrooms and marked differences between male instructors with high minority CED versus that of high non-minority CED did not exist (Figure 4-16). Consequently, female instructors with high non-minority CED were more willing to utilize an outdoor classroom than instructors with high non-minority CED (Figure 4-16). When assessing the above according to years experience only, instructors having less than 10 years experience were more willing to utilize an outdoor classroom than instructors having greater than 10 years teaching experience (Figure 4-17). Lastly, when assessing the above according to years experience and CED, instructors having less than ten years experience with both high minority and non-minority CED exhibited markedly higher willingness than that of instructors having greater than 10 years teaching experience.

Discussion

Overall, efficacy levels of instructors with high minority CED were consistently lower than that of instructors with high non-minority CED. Consistently diminished efficacy levels were evidenced upon analysis of CED and all independent variables analyzed (Table 3-1). Traditionally, teachers of minority students have believed that science reasoning and application was too challenging (King et al., 2001) and that minorities lacked ability to extract higher order principles from scientific disciplines (Beane, 1988); this diminished efficacy exhibited from instructors with high minority CED is consistent with these findings.

Efficacy affects both a teachers' effort as well as the goals that ensue for their classroom (Tschannen-Moran & Hoy, 2001). Instructors with high non-minority CED showed efficacy levels indicative of their abilities to get their students to value learning and motivate students who show low interest in science learning. However, the low efficacy exhibited for instructors with high minority CED was indicative of uncertainty in abilities to foster value for learning in their students, motivate students who show low interest, or get through to the most difficult students. The extent of teachers' confidence in their ability to affect their students' learning is a determining factor of students' performance in their classroom (Tschannen-Moran & Hoy, 2001).

Although mean OE responses exhibited from instructors with high minority CED were consistently lower, instructors with high minority CED and instructors with high non-minority CED all exhibited low mean OE responses for both environmental and general science curriculums. This marks a consistent lack of confidence and belief in all students' abilities to learn science and should be a point of concern for all science educators. Although instructors with high non-minority CED exhibited low mean OE responses, they nevertheless exhibited markedly high mean PTE, CM, and SE responses to counteract this deficit in student expectations, unlike that of instructors with high minority CED who had consistently lower PTE, CM, and SE responses.

Literature has suggested that successful instruction of minorities results from stringent outcome expectations supported through positive beliefs (Ladson-Billings, 1994). It has also been suggested that lowered expectations based on racial factors impair the process by which minority students are motivated and distort the way their achievements are shaped (Payne, 1994). These notions are perhaps true for education in general; however, here, it was demonstrated that both instructors with high minority as well as instructors with high non-minority CED exhibited relatively low OE responses when related to student outcomes in environmental and general science. This indicates all respondents (science instructors) question whether their students have the ability to learn science. While this notion is indeed more prevalent in high minority science classrooms, it does have some bearing on OE beliefs in all science classrooms as demonstrated in this research.

According to findings herein, CM and SE beliefs are the two major factors in the diminished efficacy of instructors with high minority CED. A link exists between teacher self-efficacy and the conditions present that impinge on the successful completion of work goals (Metz, 1978). Classroom management is critical for teachers' architecture of operation for their students. While all four dimensions of efficacy (PTE, OE, CM, and SE) were consistently low for instructors with high minority CED, markedly low mean CM and SE responses were evidenced for instructors with high minority CED. This diminished CM and SE handicaps teachers' decisions concerning daily assignments and work goals that are vital for smooth classroom operations (Rosenholtz, 1987). Loss of classroom control increases stress levels, thus decreasing career satisfaction, resulting in a lowered sense of self-efficacy because of teachers' inability to control their classroom environment (Rosenholtz, 1987). Consequently, instructors with high minority CED were more confident in their PTE than they were in their OE, CM, and SE; however, these Instructors lacked the necessary skills to maintain relationships with minority students, control disruptive behavior, and keep their curricular objectives on schedule; this, along with their diminutive OE beliefs, has the potential to result in diminished learning for students as CM and SE factors would impinge upon their learning time, ultimately nullifying their slightly increased PTE beliefs.

Interestingly, when examining mean efficacy dimension and grade level, OE responses for middle school science instructors were higher than that of high school science instructors, suggesting that a decrease in OE beliefs for science is proportional to student grade promotion; PTE levels were not markedly different when comparing grade level, however, middle school level responses for CM and SE were lower than that of high school level science instructors, presumably due to middle school student level age and maturity impacting instructors' CM and SE beliefs.

Bandura (1996) suggests a theory that efficacy is most affected within the first year of instruction; these years are the most pivotal to development of instructors' efficacy belief system. Efficacy levels for more experienced instructors, although lower for instructors with high minority CED, were not drastically different from instructors with high non-minority CED. However, instructors with less than ten years experienced exhibited significantly lower efficacy levels when their CED was high minority when compared with that of non-minority. Perhaps science teacher efficacy beliefs and student perceptions are not static, but may be impressed upon with experience.

Instructors with high non-minority CED currently utilized an outdoor classroom more than instructors with high minority CED. Overall, there was markedly lower outdoor classroom utilization from instructors with high minority CED; although female and more experienced science instructors' usage was relatively consistent for instructors having either CED. Many studies have examined the differences in the lowered-level of minority versus non-minority involvement in environmental issues, assessing perceptions, attitudes, concerns, support level, knowledge, and environmental awareness (Taylor, 1989). Many hypotheses are proposed to account for these differences (Taylor, 1989); the neglect in utilization of outdoor classroom resources by instructors with high minority CED should be highlighted as a concern of interest. Science instructors having either CED responded that they would be willing to utilize outdoor classrooms. Consequently, more experience instructors were less willing to implement this proposed strategy.

Research Implications

The consistently low efficacy scores referenced herein for science instructors with high minority CED should be a critical point of concern for our science education policy makers, administrators, and instructors. The disturbing yet consistent trend of deficit in science teacher efficacy among science educators with high minority CED must be addressed. Obviously these instructors feel they have the necessary knowledge to teach science (PTE); albeit lower than instructors with high non-minority CED, this perception was clearly much higher than that of the other dimensions measured.

If these instructors believe they can teach, why are they refusing to adequately educate minority students in science?

Many instructors arrive with a perception of poverty and stereotypes that inhibit them from challenging students, while others feel sorry for their minority students and don’t want to impress upon them to think and work; they feel as though these students have a hard enough time dealing with life. Some of these instructors just simply believe that their minority students can’t grasp scientific concepts, so they don’t teach these concepts. How can these students be expected to excel in science if the are not given an adequate science foundation? These perceptions prevent science instructors with high minority CED from relaying fair and adequate scientific information to their students, resulting in a group of students (minority) who are generally unable to understand and/or grasp crucial scientific concepts. These students also become uninterested in science as a whole, due to the fact that these instructors don't stress the importance and significance of science as related to society and future careers because of their instructors' perception that minority students won't grasp scientific concepts.

In urban or high minority communities, outdoor learning areas are considered unpredictable and unsafe, as a result, many science instructors refuse to utilize them or simply refuse to take part in any activity involving outdoor classrooms. The notion that all schools in urban areas are subject to outdoor dangers is a misconception that is widely accepted by many science instructors, so they refuse to utilize outdoor areas or promote outdoor careers and/or activities. Due to the lack of outdoor education, minority students have no basis for knowledge of the natural environment or potential fields related to this discipline of science. Instructors are often unfamiliar with their students' community and surroundings and don't feel conformable stepping out into a community that differs drastically from their own. This refusal to utilize outdoor classrooms will prove damaging as many minority students will never be exposed to practical scientific applications due to instructors' lack of engagement and acclimation with their students' community and surroundings.

Due to the low number of minorities in science careers, the majority of science instructors are non-minority and are unable to relate to minority students' behavior patterns, life experiences, and cultural expressions; hence, these instructors become socially inept in the context of their learning environment, and are unable to control their classrooms or relate to their students, especially in situations where higher order thinking is involved. These instructors are not successful in controlling disruptive behavior, enforcing classroom rules, and/or responding to defiant students. These instructors are also sometimes unwilling to engage with their students and establish common interests to create relationships with their students to determine what CM practices would be effective to allow effective science instruction.

To date many incentives drive instructors to teach science in urban areas. Due to a need for educators in high minority schools, many incentives (e.g. student loan pay-off) are available for instructors who work in "urban" and/or low socioeconomic areas. As a result of these incentives, many instructors are just doing their time and lack concern for their students' outcomes in science. After the incentives are obtained these instructors often leave urban schools for more economically stable suburban schools; leaving many students without adequate understanding of baseline scientific objectives.

The above factors are practices that impede instructors' ability to teach and inhibit positive beliefs for their students. Instructors must refrain from any practice that alters their curricular goals in science based on student ethnicity and/or socioeconomics.

Initiatives are rising that seek to advance minority participation in sciences. While these initiatives are useful, they are futile as many minority students are being taught by science educators with low efficacy. These students don't receive the basics in science needed to spark interest and drive enthusiasm. For environmental careers, most minorities don't receive the exposure to outdoor education to spark interest in certain environmental areas (park ranger, biologist, ecologist, forestry, soil science, etc.) and thus don't pursue these careers. For general science careers, many times minorities lack basic science education essentials needed to excel in the higher education scientific arena. Based on the finding presented here, it is believed that science teacher efficacy plays a huge role in the lack of achievement and lack of representation of minorities in these fields.

Professional development initiatives should be promoted that not only target methods for enhancing science curriculum, but also target practices that enhance teacher efficacy, especially when related to OE, CM, and SE for instructors with high minority CED. Instructors should not let students' behavior, cultural expressions (e.g. dialect or perceived language barrier), sociological, and/or economic problems delegate what component of their daily lesson will be presented. Professional development for minority student instruction should foster instructor acclimation with their students' community, so that instructors will be able to interact with their students on varied levels and gain insight on their students' methods and styles of learning. Initiating professional development in this area will change the perception of disparity blocking the full educational potential to be gained from many science educators in minority schools.

Research Recommendations. Future research directives initiated as a result of this study should incorporate qualitative data to obtain a more detailed explanation and rationale behind science teacher efficacy beliefs as they pertain to minority success in environmental and general science; quantitative data may be more stringent with qualitative backing. Future research directives should also assess efficacy of instructors exposed to both high minority and non-minority CED; efficacy levels could then be assessed for each treatment and compared to trace and/or confirm any deficit in efficacy based on CED. Lastly, minority student efficacy should be examined and compared to trace students' own self-efficacy beliefs in science: Do they change over time? Do they change with age? Are they different for students in mixed race schools or majority minority schools when compared to that of non-minority schools?

Further Consideration. A major limitation of this study is the difficulty in obtaining a causal conclusion from cross-sectional data. A causal-comparative analysis cannot pinpoint a definitive causal link between science teacher self-efficacy and the achievement of minorities in environmental and general science. There are numerous variables other than science teacher self-efficacy that may impede minority success in science; these include: students' own self-efficacy, socioeconomic factors, non-attainable academic resources, familial structure, etc. (Bandura, 1986; Pajares, 1996). Nonetheless, low science teacher efficacy has been shown to substantially lower student outcomes and achievement levels (King et al., 2001; Ashton & Webb, 1986; Hoy, 2000).

To maintain equality in our science curriculums educators must refuse to alter curricular goals because of students' behavior, ethnicity, socioeconomic status, and/or perceived intellectual abilities. The consistently low efficacy scores referenced herein for science instructors with high minority CED can be utilized to highlight science teacher efficacy as a critical point of concern as well as a crucial factor in tracing the genesis of the minority achievement gap in science.

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APPENDIXES

APPENDIX A

Research Instrument

Please indicate the degree to which you agree or disagree with each statement below by choosing the appropriate number to the right of the statement. For questions 1-25, please choose one answer for General Science and one answer for Environmental Science; for questions 26-51 only one answer is required.

If you do not teach environmental science, please answer the environmental science questions based on the environmental curriculum embedded within the science subjects you teach (Biology, Earth Science, etc.). **(Please provide an answer for all questions)**

1	**2**	**3**	**4**	**5**
Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

	General Science	Environmental Science
1. When a student does better than usual in science it is often because the teacher exerted a little extra effort.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
2. I will continually find better ways to teach science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
3. Even if I try very hard, I will not teach science as well as I will most subjects.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
4. When the grades of students improve, it is often due to their teacher having found a more effective teaching approach for science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
5. I know the steps necessary to teach science concepts effectively.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
6. I will not be very effective in monitoring science activities.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
7. If students are underachieving in science, it is most likely due to ineffective science teaching.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
8. I will generally teach science ineffectively.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
9. The inadequacy of a student's science background can be overcome by good teaching.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
10. The low science achievement of some students cannot generally be blamed on their teachers.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
11. When a low-achieving child progresses in science, it is usually due to extra attention by the teacher.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
12. I understand science concepts well enough to be effective in teaching basic high school science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
13. Increased effort in science teaching produces little change in some students' science achievement.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
14. The teacher is generally responsible for the achievement of students in science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
17. I will find it difficult to explain to students why science experiments work.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
18. I will typically be able to answer students' science questions.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐

19. I wonder if I have the necessary skills to teach science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
20. Given a choice, I will not invite the principal to evaluate my science teaching.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
21. When a student has difficulty understanding science concepts, I will usually be at a loss as to how to help the student better understand.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
22. When teaching science, I will usually welcome students' questions.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
23. I do not know what to do to turn students on to science.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
24. I often utilize an outdoor classroom to reinforce science learning.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
25. I am willing to utilize an outdoor classroom to reinforce science learning.	1-☐2-☐3-☐4-☐5-☐	1-☐2-☐3-☐4-☐5-☐
26. I am able to control disruptive behavior in the classroom	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
27. I can get children to follow classroom rules.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
28. I am able to calm a student who is disruptive or noisy.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
29. I am able to establish a classroom management system with each group of my students.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
30. I am able to keep problem students from ruining an entire lesson.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
31. I respond well to defiant students.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
32. I make my expectations about student behavior clear to my students.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
33. I am able to establish routines to keep activities running smoothly.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
34. I am able to get students to believe they can learn.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
35. I am able to help my students value learning.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
36. I am able to motivate students who show low interest in school work.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
37. I am able to assist families in helping their children do well in school.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
38. I am able to improve the understanding of a student who is failing.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
39. I am able to help my students think critically.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
40. I am able to foster my students' creativity.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	
41. I am able to get through to my most difficult students.	1-☐ 2-☐ 3-☐ 4-☐ 5-☐	

APPENDIX B

Supplemental Teacher Information Form

Classroom Information **(Please provide an answer for all questions)**

42. How many students do you instruct per day? _____
43. What grades do you instruct? _____
44. How many (number per ethnic group) of the following do you instruct per day? Hispanic/Latino students _____ ; Black students _____ ; White students _____ ; Asian/Pacific Islander students _____ ; American Indian/or Alaskan _____ .
45. How many students of an ethnicity not listed in the above four questions do you instruct per day? _____

Teacher Information **(Please provide an answer for all questions)**

46. How many years of teaching have you completed? _____
47. How many years as a science teacher have you completed? _____
48. What percent of your science curriculum involves environmental education? _____
49. What is your educational background (degrees, etc.)? _____
50. How many years have you been employed at your current school? _____
51. What is your age? _____
52. What is your gender? _____
53. What is your ethnicity? Choose one of the following:
    a. ☐-Black
    b. ☐-White
    c. ☐-Hispanic/Latino
    d. ☐-Asian/Pacific Islander
    e. ☐-American Indian/or Alaskan
    f. ☐-Other: ________________
54. Are you regularly engaged in outdoor activities outside of work (e.g. camping, nature trail walking, hiking, etc.)? _____ . If yes, please specify type of outdoor activity: _____

APPENDIX C

Consent Form

Consent Form

Project Title: Analysis of Mean Level Efficacy for General and Environmental Science Curriculum.

"I, ____ , hereby authorize Mr. Bryan K. Taylor (BS, Biology; MS, Bio-Science), PhD candidate for Environmental Science at Oklahoma State University, to administer a four-page research instrument. I understand the following:

1. The purpose of this research is to examine teacher efficacy.
2. The procedure involves answering questions from a three-page research instrument (questionnaire).
3. Participants would take part in a post interview prompted from their written responses on the three-page research instrument (questionnaire).
4. There are no known risks associated with this project which are greater than those ordinarily encountered in daily life.
5. The benefit of this research is to provide more information on environmental science teacher efficacy.
6. My responses are confidential and anonymous; data sheets shall not contain names or history of participants; data will be condensed and used for doctoral thesis; all data will be kept in a locked file drawer until research activities terminate (up to 1 year); only researcher and advisor (listed as contacts below) will have access to data. The OSU Individual Research Board (IRB) has the authority to inspect consent records and data files to assure compliance with approved procedures.
7. This process shall not directly or indirectly affect my students or district in which I am employed.
8. I will not be compensated for my responses.
9. My participation is voluntary; I am under no obligatory constraints to participate; and I may withdraw my consent and participation from this project at any time."

I may contact Dr. Richard Bryant (405) 744-8005 or Bryan K. Taylor at (918) 269-9349. For information on subjects' rights, I may contact Dr. Sue Jacobs, IRB chair, 415 Whitehurst Hall, (404) 744-1676, Oklahoma State University, Stillwater Oklahoma, 74078.

I have read and fully understand the consent form. I sign it freely and voluntarily. A copy of this form has been given to me.

Date: ______________________

Phone Number: _____________

Signed: ____
Signature of Participant

I certify that I have personally explained this document before requesting that the participant sign it.

Signed: ____
Signature of Researcher

APPENDIX D

Institutional Review Board Approval Letter

Oklahoma State University Institutional Review Board

Date:	Friday, April 08, 2005
IRB Application No	AG0539
Proposal Title:	Analysis of Mean Level Personal Teacher Efficacy and Outcome Expectancy for Science Curriculum Within Contrasting Ethnic Classroom Environments: Instructor Perceptions of Environmental Curriculum and Practical Applications Therein
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved   Protocol Expires: 4/7/2006

Principal

Bryan Taylor
9712 E. 110th St. N.
Owasso, OK 74055

Richard Bryant
229 Willard
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, emct@okstate.edu).

Sincerely,

Sue C. Jacobs

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Bryan Keith Taylor

Candidate for the Degree of

DOCTOR OF PHILOSOPHY

Dissertation: ANALYSIS OF ENVIRONMENTAL AND GENERAL SCIENCE EFFICACY AMONG INSTRUCTORS WITH CONTRASTING CLASS ETHNICITY DISTRIBUTIONS: A FOUR DIMENSIONAL ASSESSMENT

Major Field: Environmental Science

Biographical:

Personal Data: Born in Tulsa Oklahoma on August 18, 1974, the son of Lennice Marie Taylor; married (Elizabeth) with two children (Ryan and Randi).

Education: Graduated from Booker T. Washington High School in Tulsa, Oklahoma in May, 1992. Attended Langston University in Langston, Oklahoma and received a Bachelor of Science in Biology in May, 1997. Received Master of Science in Biomedical Science from the College of Veterinary Medicine at Oklahoma State University in Stillwater, Oklahoma in December, 2001. Requirements completed for the degree of Doctor of Philosophy in Environmental Science at Oklahoma State University in Stillwater, Oklahoma in December, 2005.

Professional Experience: Employed by the Tulsa District, US Army Corps of Engineers as an Environmental Biologist in the Regulatory Office (February 2002 to present). Also, employed as an adjunct Instructor for the Department of Math and Sciences at Tulsa Community College (August 2005 to present). Employed previously as a Research Associate for the Department of Pathobiology, College of Veterinary Medicine, Oklahoma State University (May 1997 to December 2001).

Professional Memberships: Society for Environmental Scientists and American Society for Cell Biology