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Science Self-Efficacy and School Transitions: Elementary School to Middle School and Middle School to High School

Brandi Lue Lofgran
Brigham Young University - Provo

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Brandi B. Lofgran

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Leigh K. Smith, Chair
Lynnette B. Erickson
Erin F. Whiting

Department of Teacher Education

Brigham Young University

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ABSTRACT

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Brandi B. Lofgran
Department of Teacher Education
Master of Arts

This study examined the science self-efficacy beliefs of students before and after transitions from elementary to middle school and middle school to high school. The purpose was to explore whether those beliefs changed with grade level, gender, and ethnicity. Data were collected through a modified Self-Efficacy Questionnaire for Children (Muris, 2001), which was adapted to focus on science self-efficacy. Multiple ordinary least squares regression was used to analyze the data. All grade levels showed a clear decline in science self-efficacy after sixth grade with females, Hispanic students, and ninth graders showing the greatest decline in science self-efficacy.

Keywords: self-efficacy, science, school transitions, elementary school, middle school, high school

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Chapter 1

Introduction

In the reauthorization of the Elementary and Secondary Education Act (U.S. Department of Education, 2010) public schools are charged with supporting all students, "from English Learners and students with disabilities to Native American students, homeless students, migrant students, rural students, and neglected or delinquent students" (p. 3) in achieving academic success in all subjects. Clearly, ensuring achievement for all U.S. students in every subject area is a worthy goal. Unfortunately, however, students across the country have underperformed on state and national assessments in all tested content areas in recent years (Usher, 2011). In 2010, for example, 38% of the nation's schools failed to make adequate yearly progress in literacy, mathematics, and science (Usher, 2011). It is estimated that number increased in 2011 to 48%, according to the official State Consolidated Performance Reports (Usher, 2011).

When looking specifically at science achievement, students' performance on both national and international science assessments over the past several decades has been equally dismal. In 2000, only 32% of eighth grade students and 18% of twelfth grade students scored at or above *proficient*, according to *The Nation's Report Card: Science 2000* (O'Sullivan, Lauko, Grigg, Qian, & Ahang, 2000). Recent international comparisons between the science knowledge and skills of children in the U.S. and the performance of their peers in other countries also indicate cause for concern. For example, 15-year-old U.S. students performed below average, behind Finland, Canada, Japan, and a number of other industrialized nations, on the *Programme for International Student Assessment* 2006 science scale (Organisation for Economic Co-operation and Development, 2007). Results of the fourth, and most recent, administration of the *Trends in International Mathematics and Science Study* (TIMSS, 2007) also showed that the average science scores of U.S. students continue to lag behind those of students in various countries in Asia and Europe and demonstrate “no measurable difference” since the first TIMMS was administered in 1995 (Gonzales et al., 2008, p. 33). This lack of student achievement in science over time is especially alarming when considering the growing need for science and technology professionals in the workforce (National Research Council [NRC], 1996; Osborne, Simon, & Collins, 2003; U.S. Department of Education, 2010).

The challenge of improving students’ science achievement so that all children and adolescents find success and are prepared to “meet college- and career-ready standards” (U.S. Department of Education, 2010, p. 3) does not have an easy fix. This is particularly true when considering that populations in contemporary classrooms across the U.S. continue to become increasingly diverse. Indeed, these shifting demographics, which introduce a greater mixture of languages, ethnicities, and cultural backgrounds into public schools (Delpit, 1996), add to the already complex task of teaching groups of students who have traditionally brought other unique qualities to classroom populations (e.g., family background, physical ability, aptitude or intellectual ability, socioeconomic status, background knowledge; Frey, Fisher, & Moore, 2005; Gee, 2001; NRC, 1996; Tough, 2006). Given the variety of factors to be acknowledged and attended to in every classroom, it is not surprising that many schools struggle to meet mandated benchmarks established as indicators of students’ academic achievement (Novak & Fuller, 2003).

Science Self-Efficacy

Sociocultural diversity, abilities and aptitudes, and prior knowledge, however, are not the only issues affecting science achievement in today’s classrooms. Research suggests that affective variables, such as students’ interests, attitudes toward science, motivation, academic expectations, and science self-efficacy have also been tied to student achievement in science (Jenkins & Nelson, 2005; Lau & Roeser, 2002; Neathery, 1997; Osborne et al., 2003; Pajares, 1996; Tavani & Losh, 2003).

In general, students' self-efficacy affects their choice of activities, settings, and coping strategies through their expectations of future successes or failures (Bandura 1977, 1997; Zimmerman, 2000). Self-efficacy also determines the amount of effort students are willing to expend and their persistence, even in the face of obstacles (Bandura 1977, 1997; Zimmerman, 2000). Thus, when success is achieved, it builds and supports self-efficacy, which then positively influences future choices (Bandura 1977, 1997). Low self-efficacy does the same thing in reverse, negatively affecting choices and encouraging the avoidance of those activities where failure is anticipated (Bandura 1977, 1997; Zimmerman & Clearly, 2006). This is particularly thought provoking in academic settings, since negative influences on academic self-efficacy can cause a downwards spiral reciprocally. In these cases, having low academic self-efficacy leads to lower academic expectations, which leads to seeking peers with similar expectations, which leads to devaluing the importance of school, which leads to diminishing future career goals, and so on and so on (Zimmerman & Clearly, 2006).

Research has confirmed that science self-efficacy, students' "belief in their ability to succeed in science tasks, courses, or activities" (Britner & Pajares, 2006, p. 486), influences a variety of factors related to student achievement. Indeed, studies suggest that students with higher science self-efficacy are more engaged and more successful in science than their peers with lower science self-efficacy (Bouffard-Bouchard, Parent, & Larivee, 1991; Lau & Roeser, 2002). For example, Lau and Roeser (2002) found that students who feel confident in their capabilities in science tended to place more value in science than students with less confidence.

These students also reported being more engaged emotionally, cognitively, and behaviorally immediately after taking a standardized science test. They went on to report that they paid attention and participated more in class, did more homework, and used self-regulatory strategies more often when learning science than their less efficacious peers. Additionally, the study revealed that classroom engagement was related to higher test scores and grades, as well as participation in more science-related extracurricular activities and students' anticipated choices to study science or to pursue science as a career path. A related study (Liu, Hsieh, Cho, & Schallert, 2006) also suggested that high self-efficacy played an important role in improving science achievement for students who did not like science.

While it is clear that there exists a reciprocal relationship between science self-efficacy and success in science in school, a variety of factors serve to mediate this connection, including students' ability, attitudes, and prior experiences (Schunk, 1991). Thus, a multitude of contextual factors may influence students' perceived capability and, therefore, their academic performance (Bandura, 2006a; Suldo & Shaffer, 2007). School transitions are one aspect of schooling that has been shown to influence students' general academic motivation and interest in learning (Harter, Whitesell, & Kowalski, 1992), but has not been studied in connection with students' science self-efficacy.

School Transitions

Historically, school transitions, particularly from elementary to middle school or junior high school and from middle school or junior high school to high school, are periods of heightened physical and emotional upheaval for students (Harter et al., 1992). This is because students are experiencing changes on many levels: the physical and cognitive changes of puberty and adolescence, the actual environmental changes introduced by moving to new schools, and the resulting social changes these physical and emotional changes may precipitate.

During the time students are transitioning from elementary school to middle school or junior high and then on to high school, they are also transitioning through puberty into adolescence. Puberty brings with it physical changes, such as deepening voices and the appearance of acne, which can be embarrassing and awkward for students. Changes due to emotional and sexual development also affect adolescents' image of themselves, their interactions with their peers, and their perceptions of their school's social environment (Dworetzky, 1993).

Along with these physical changes, students undergo cognitive changes throughout adolescence. It is during this time that students begin to be able to think more abstractly, they develop more sophisticated information-processing strategies, their reasoning and decision-making skills increase, as does their ability to reflect on themselves (Wigfield, Lutz, & Wagner, 2005). These cognitive changes affect their academic capabilities.

Despite these marked advancements in cognitive abilities that come with adolescence, research has shown that transitioning to a new school context can be taxing on many students' perceptions of their capabilities (Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991) and confidence, often resulting in diminished student perceptions of their overall academic competence (e.g., Harter et al., 1992). There may also be a marked decline in student motivation, interest in school, academic achievement, self-esteem, and attitude during these environmental transitions (e.g., Eccles & Roeser, 2011), particularly in science (Osborne et al., 2003). Although, it is unclear how these periods of change affect science self-efficacy, it is important to note that according to Zimmerman and Clearly (2006), these detrimental effects felt by students during these transitions do not have to be permanent. Rather, transitioning to a new school context can benefit students' growth and development if self-efficacy is already established prior to the move. In these cases, high self-efficacy permits or enables students to persist in the face of obstacles, and believe in their capability to succeed.

The environmental change of moving to a new school introduces students to many changes, both in their physical surroundings and in the organizational structure of the school. Typically, middle schools or junior high schools are larger than elementary schools, with several elementary schools feeding into one middle school or junior high school. Thus, this transition introduces the student to a larger school building as well as a larger, more diverse student body (Eccles & Roeser, 2011). Classrooms are more likely to be organized departmentally, with students circulating through several classes a day, and teachers teaching a different group of students every class period (Eccles & Roeser, 2011). This organizational structure can make it difficult for students to build the close relationships with their teachers that they were accustomed to in elementary school (Eccles & Roeser, 2011; Wigfield et al., 2005). Thus, the school environment often feels more impersonal during this particularly salient time period during adolescence, when students are seeking for a sense of belonging and community within their new school context (Eccles & Roeser, 2011).

Expectations of academic performance and the purposes of schooling also seem to change as students move from one institutional level to the next. As students move into secondary schools, more emphasis is placed on individual performance and preparation for college and careers. For example, it is during the transition from elementary school to middle school or junior high school that teachers begin to place higher expectations on students, particularly when it comes to managing their own schoolwork in and outside of the classroom

(Zimmerman & Clearly, 2006). Although it has not been studied during school transitions, it should be noted that high academic self-efficacy can empower students to be more self-directed learners, thus potentially helping them through this period of changing expectations (Zimmerman & Clearly, 2006). Tracking, "the system of placing some students in college preparatory courses and others in easier math and science courses" (Dornbusch, as cited in Stanford University, 1994, p. 1), is another example of a structural or institutional change introduced as students move from middle school or junior high school to high school.

A new school context also introduces with it new social expectations and roles. Social supports and pre-transition friendships are often disrupted (Benner, 2011). For some students, the loss of peers and feelings of belonging during these times is thought to be detrimental to their development (Weiss & Bearman, 2007). Indeed, this loss can be particularly difficult for adolescent students during a time when they seek to identify themselves through their peer groups, clubs, or religion (Miller, 2002). For other adolescents, however, the change in schools can be beneficial, in that the new environment allows them to reinvent themselves (Weiss & Bearman, 2007). In these cases, the transition is especially advantageous for students who felt isolated in their former school context (Weiss & Bearman, 2007).

It is clear that the physical, institutional, and social changes students experience as they transition through adolescence and from one school level to the next affect their general feelings of self-concept, motivation to learn, and attitudes towards school. It is unknown, however, if students' science self-efficacy is affected at these key transition points in their schooling.

Statement of the Problem

During the current climate of academic accountability, educators face the challenge of improving student achievement in science during their K-12 schooling as well as helping them see their potential in the subject in the future. Because students' achievement in science and their motivation to pursue science beyond the twelfth grade has shown to be closely tied to their science self-efficacy, it is important to understand the contextual factors that may positively or negatively impact students' beliefs about their ability to succeed in science. Although it is clear that students' attitudes toward science deteriorate as they move from elementary to secondary school (Osborne et al., 2003), the impact of these key education transition points on students' science self-efficacy is not understood. However, this information will likely benefit educators as they work to help students understand and achieve their potential in science and science related activities (Pajares & Miller, 1994).

Statement of the Purpose and Research Question

The purpose of this study was to examine students' science self-efficacy at the transition from elementary school to middle school and the transition from middle school to high school in order to describe science self-efficacy at these key school transitions for differing student populations. The question investigated in this study was: How do the science self-efficacy beliefs of elementary, middle, and high school students differ across grade level, gender, and ethnicity at two key school transitions?

Chapter 2

Review of the Literature

This study was conducted to examine students' science self-efficacy at two major school transitions: elementary to middle school and middle school to high school. Thus, pertinent literature explaining what is known about self-efficacy and its sources are discussed in the following section. This discussion is followed by a review of the literature on academic self-efficacy, science self-efficacy, and school transitions and self-efficacy.

Nature of Self-efficacy

Self-efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3) and varies as a function of ability, attitude, and prior experience (Schunk, 1991). Bandura (1993) maintains that ability is not a fixed attribute, but rather a "generative capability in which cognitive, social, motivational, and behavioral skills must be organized and effectively orchestrated to serve numerous purposes" (p. 118). This is the difference between possession of knowledge and skills and the ability to use that knowledge and those skills in appropriate situations, in prime as well as stressful circumstances (Bandura, 1993, 1997). The ability to use situated knowledge and skills requires self-efficacy (Bandura, 1993). Without it, persons of matching knowledge and skills can perform poorly, adequately, or exceptionally depending on the "fluctuations of self-efficacy" (Bandura, 1993, p. 119).

Because self-efficacy is a personal judgment of capability (Bandura, 2006a) and influences the way people think, feel, motivate themselves, and behave (Bandura, 1993), it has been shown to be a good predictor of performance (Bandura, 1997; Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Schunk, 1991; Suldo & Shaffer, 2007). Perceived competence and self-efficacy for success predisposes individuals to dedicate more time, as well as cognitive and emotional resources to those tasks about which they feel most efficacious (Lau & Roeser, 2002), thus almost ensuring success (Bandura, 1997). Efficacious people are able to visualize themselves successfully completing tasks by providing their own positive guides and supports, while inefficacious people fight fears of self-doubt and visualize failure scenarios (Bandura, 1993, 1997; Pajares, 1996).

Self-efficacy is not a general belief in overall ability, but a context specific judgment of capability (Bandura, 1997). As such, self-efficacy varies according to *magnitude*, or the level of difficulty of the task; *generality*, how specific perceived self-efficacy is; and *strength*, or the amount of certainty the individual has that a specific task can be performed (Bandura, 1977; Zimmerman, 2000). These three factors are important contributors to self-efficacy as they determine how specific or broad beliefs are, how well beliefs can generalize to similar contexts and transfer across activities (Zimmerman, 2000), and in understanding how new experiences will either add to or detract from already established self-efficacy (Bandura, 1986).

Sources of Self-Efficacy

Self-efficacy, itself, is formed from four distinct sources of information: enactive mastery experiences, vicarious experiences, verbal persuasions, and physiological and affective states (Bandura, 1997). Of these, mastery experiences have shown to be the strongest source of self-efficacy development, although all four sources contribute to personal self-efficacy (Bandura, 1997). Each will be discussed at length in the following sections.

Enactive mastery experiences. Enactive mastery experiences are the strongest and most influential sources of personal self-efficacy information because they provide the most authentic evidence of capability (Bandura, 1997). In educational settings, for example, each time an academic task is completed, the student evaluates and interprets the process and results as either successful or unsuccessful (Bandura, 1997; Usher & Pajares, 2006). Success raises perceived self-efficacy, while repeated failures lower them, particularly failures that occur early in the development and exploration of new mastery experiences (Bandura, 1977). If strong self-efficacy is already established, however, occasional failures will have no negative effect on self-efficacy (Bandura, 1977, 1997).

Successful mastery experiences are more likely to influence self-efficacy when they are self-directed and when it is believed the success is a result of skill rather than effort or external aides (Bandura, 1977, 1997). It is not always possible, however, to experience everything on one's own. This is when vicarious experiences can help provide a bridge to building self-efficacy.

Vicarious experiences. Although not as powerful as enactive mastery experiences because of their lack of authenticity, there are instances when the development of self-efficacy is especially open to vicarious information (Bandura, 1997). Uncertainty about or no direct knowledge of one's capabilities (Usher & Pajares, 2006), and mixed experiences of failure and success (Bandura, 1997) are two instances when modeling, as a form of vicarious experience, can help teach appropriate strategies and form positive self-efficacy. Observing the success of others can give the student observer the confidence to try and the belief that they can succeed at a particular task (Schunk, 1991), especially when students feel the model is similar to themselves in capability (Schunk, 1991; Usher & Pajares, 2006). Conversely, watching others fail can dissuade the student observer from trying and lessen motivation and self-efficacy in the process (Schunk, 1991).

Verbal persuasion. This source of self-efficacy, although somewhat limited in scope, can be useful in bolstering students' beliefs that they are capable of accomplishing difficult tasks (Bandura, 1997). When a trusted model or mentor expresses confidence in the student's ability, the student can be persuaded to put forth greater effort in order to accomplish certain tasks (Bandura, 1997; Bong & Skaalvik, 2003). Verbal persuasion works most effectively when students are given the necessary tools and aides to accomplish the task along with conditions that will facilitate effective performance (Bandura, 1977, 1997; Bong & Skaalvik, 2003); Usher & Pajares, 2006). Without these in place, verbal persuasion can be easily discredited if the students fail to achieve what they were told they were capable of (Bandura, 1997).

Verbal persuasion also functions in the form of performance feedback (Bandura, 1997). Usher and Pajares (2006) posit that students who are "not yet skilled at making accurate self-appraisals, depend on others to provide evaluative feedback, judgments, and appraisals about their academic performances" (p. 127). Positive persuasive feedback increases motivation, self-efficacy, and skill as it recognizes previous successes, supports progress perceptions, sustains motivation, and boosts self-efficacy for learning (Schunk, 1991).

It is important to understand that verbal persuasion can serve as both a positive and a negative indicator in influencing self-efficacy (Bandura, 1997, Usher & Pajares, 2006). Feedback that focuses on ability underscores students' personal and potential capabilities (Bandura, 1993). Likewise, negative feedback only serves to highlight personal deficiencies, undermining self-efficacy and discouraging future attempts (Bandura, 1993). Girls are especially susceptible to verbal persuasion, with parents and teachers holding the greatest power of persuasion in encouraging or discouraging young women within the sciences (Usher & Pajares, 2006).

Bandura noted that regardless of ability, “social persuasions can discourage students of both genders from traveling academic paths that are within their capabilities” (1997, p. 137).

Physiological and affective states. As students develop and move through the school system, mental note is taken of how they respond emotionally to certain stimuli in different academic situations (Bandura, 1997; Pajares, 2006). They eventually form beliefs about how these emotional states affect their self-efficacy and their academic performance (Bandura, 1997). Feelings of stress, arousal, fatigue, and anxiety can undermine students’ beliefs about ability (Usher & Pajares, 2006), thereby setting them up for failure because of the propensity to blame negative feelings of arousal on personal inadequacies rather than situational factors (Bandura, 1977; Schunk, 1991). At the physiological level, self-efficacy influences students’ choices of behavioral settings, expectations of success, and coping strategies (Bandura, 1977). Reducing negative physiological states increases their physical and emotional well-being, encouraging improvements in self-efficacy (Usher & Pajares, 2006).

Variations in levels of self-efficacy also have an effect on physiological and affective states in students. For example, high levels of self-efficacy decrease stress, anxiety, and depression felt during task completion (Bandura, 1997; Zimmerman, 2000), giving students a feeling of peace as they approach difficult tasks (Pajares, 1996). In contrast, low self-efficacy can cause students to believe tasks are harder than they really are, which fosters more stress, depression, and an inability to see the broader picture in order to solve problems (Pajares, 1996). Additionally, students with low self-efficacy are more susceptible to developing self-handicapping coping strategies such as procrastination, self-deprecating talk, meager effort, unrealistic or overly simple goals (Pajares, 2006), and avoidance tactics (Bandura, 1977). Thus, increasing students’ physical and emotional well-being within the classroom setting and reducing negative emotional states will potentially increase their self-efficacy (Usher & Pajares, 2006) and improve performance (Bandura, 1997; Britner & Pajares, 2001). A 2007 study (Bassi, Steca, Delle Fave, & Caprara) found that highly efficacious students reported being happier, more satisfied, involved, and in control in their schoolwork. These same students were also able to concentrate better than their less efficacious classmates (Bassi et al., 2007). Similar studies have found that students with higher self-efficacy were more persistent when faced with difficult coursework, exerted more effort, and were more actively engaged during work time (Bouffard-Bouchard et al., 1991).

Interpretation of sources of information. Information obtained from the four sources of self-efficacy does not automatically influence perceptions of self-efficacy because the material or data must first be cognitively appraised by the student (Bandura, 1997; Schunk, 1991) and much depends on how it is interpreted by them (Bandura, 1997; Pajares, 1996). Indeed, self-efficacy judgments are always made in advance, before tasks are completed, with students appraising ability within a specific, meaningful domain of functioning (Bandura, 1986). This makes self-efficacy inferential in nature, as students weigh their ability or non-ability, task difficulty, external aides, situational factors, mood, physical state (Bandura, 1986; Pajares, 1996) expected expended effort, amount and pattern of success versus failures, similarity to models, and credibility of persuader or model (Schunk, 1991). In this way, it is the interpretation of the performance, not the actual performance, that informs and alters self-efficacy, perceptions of the environment, and subsequent performance (Pajares, 1996). Indeed, self-efficacy is so influential it can blind students' knowledge of their own cognitive processes by their feelings of competence or incompetence (Bouffard-Bouchard et al., 1991). For example, Lau and Roeser (2002) found that perceived competence, self-efficacy, and value of the task predisposed students to invest time and resources into specific activities. Thus, students' perception of their academic ability will promote or demote sustained academic achievement, motivation, and behavior more than their actual ability (Bouffard-Bouchard et al., 1991).

Academic Self-Efficacy

Academic self-efficacy is a student's beliefs in his or her competence to accomplish certain academic tasks within specific academic domains (Berry & West, 1993). These beliefs are also students' beliefs in their capabilities for learning certain types of curricula (Schunk, 1996). In fact, research suggests that adolescents can develop self-efficacy that is task-specific (e.g. completing a homework assignment or participating in a science fair), skill-specific (e.g. using a scale), or domain-specific (e.g. general science or biology; Bong, 2006).

Academic self-efficacy is posited to be the antecedent to motivation in an academic setting (Zimmerman, 2000) as it influences how and what types of goals are set, the expected outcomes of those goals, personal aspirations, perceptions of opportunities and the perceived impediments to those opportunities (Bandura, 1997, 2006a), expenditure of energy, and rate of performance (Zimmerman, 2000). Additionally, because self-efficacy regulates thought process, motivation, and affective and physiological states, even someone with less skill can perform well when their efficacious beliefs motivate them to try harder and persevere until they attain the success they feel capable of (Bandura, 1997). This occurs because as confidence increases, intrinsic motivation increases as well (Harter et al., 1992). Thus, students need to have positive perceptions of their own competence in order to maintain achievement motivation (Bouffard-Bouchard et al., 1991).

According to Schunk (1991) initial academic self-efficacy is based on students' aptitude and prior experience. As the student continues to learn and work, information processing, goal setting, and situational factors add to the perceptions of the initial self-efficacy, giving the student cues about how well they are learning, which the student then uses to assess self-efficacy for further learning (Schunk, 1991). Thus, self-efficacy is enhanced as students notice and remember successful strategies, tasks, and results (Bandura, 1997). Efficacious students are then better equipped to interpret past performances and transfer them into future success (Bandura, 1997).

Students with high academic self-efficacy believe in their capabilities to master academic subjects. These beliefs serve as predictors for future academic achievements (Bandura, 1993). This self-perceived efficacy empowers students with the confidence that they control their own learning (Bandura, 1993; Bouffard-Bouchard et al., 1991). It also raises academic aspirations (Zimmerman, Bandura, & Martinez-Pons, 1992), influences current academic achievement, and encourages goal setting for future task performance (Bassi et al., 2007). Additionally, higher and more specific personal performance goals are set by highly efficacious students (Berry & West, 1993) because they are able to interpret past performances and translate them into future successful performances (Bandura, 1997). Highly efficacious students are also more likely to choose to engage in challenging tasks (Bassi et al., 2007; Berry & West, 1993; Bouffard-Bouchard et al., 1991; Schunk, 1981; Zimmerman, 2000). In this way, self-efficacy becomes a better predictor of academic achievement than actual ability because these beliefs mediate students' knowledge of themselves, the tasks they perform, the perceived success or failure they attain, and future attempts at similar tasks (Bandura, 1986, 1997). In fact, because intelligence only accounts for about 25% of variance in achievement (Lau & Roeser, 2002), it is postulated that it is better for students to have self-efficacy that slightly exceeds their actual ability

(Bandura, 1997; Pajares, 1996). This motivates students to extend their efforts to achieve perceived capability (Pajares, 1996).

Science Self-Efficacy

As suggested previously, a student's academic beliefs are not global across academic domains. Rather, students' level of self-efficacy has shown to correlate with various specific academic subjects and their associated skill sets, including achievement in writing, mathematics, and science. In writing, for example, self-efficacy has been associated positively with task goals, self-concept, and self-regulation (Pajares, Britner, & Valiante, 2000) and has a direct effect on writing apprehension and performance (Pajares & Johnson, 1996). Interestingly, Pajares and Johnson (1996) found native English-speaking Hispanic students consistently reporting lower self-efficacy for writing than their white classmates, experiencing higher apprehension, lower aptitude, and lower performance scores.

In other subject areas, Skaalvik and Skaalvik (2004) found that when controlling for previous achievement, self-efficacy predicted subsequent achievement in mathematics and verbal domains. Similarly, Pajares and Miller (1994) found that in mathematics, students' self-efficacy was shown to be more predictive of achievement in mathematics problem solving than gender, self-concept, prior experience, and perceived usefulness of mathematics. They also found that males generally have higher mathematical self-efficacy, performance, self-concept, and lower mathematical anxiety than their female counterparts, while Skaalvik and Skaalvik (2004) found that girls had higher self-efficacy than boys in the verbal domain, but there was no significant difference in math. In another study, Zimmerman and Martinez-Pons (1990) found that both verbal and mathematical self-efficacy increased with age and grade level.

Although this study is specifically concerned with science self-efficacy at key school transitions, it is important to mark how science self-efficacy is related to science achievement because it shows relevancy and helps explain the academic choices students make (Bandura, 1997). Liu et al. (2006) found that self-efficacy played a significant role in improving science achievement for students who did not like science. Britner and Pajares (2001) found that science self-efficacy predicted achievement for white students but not for African American students; there is currently no information on how science self-efficacy affects Hispanic students. However, as previously mentioned, Pajares and Johnson (1996), found that Hispanics had substantially lower self-efficacy for writing than white students and subsequently more apprehension for writing. These findings led Pajares and Johnson (1996) to postulate whether Hispanic students' low self-efficacy attributed to those students becoming or remaining "at risk" within the school system. Thus, students who may have the ability, but lack the belief that they can succeed in a science class, may fail to achieve what they otherwise could (Beghetto, 2007). This perceived science competence is also directly related to motivation to learn, achievement, and future aspirations within science related fields (Beghetto, 2007; Britner & Pajares, 2006; Lau & Roeser, 2002). Given the reported decline of interest in science, especially for girls, that continues throughout secondary school and into college (Beghetto, 2007; VanLeuvan, 2004), these findings are of particular importance as students move through the upper elementary grades and into middle school.

In addition to impacting student achievement in science, studies also indicate that the level of students' science self-efficacy also influences their academic choices. For example, the stronger a student's belief in his or her ability to do well in science, the more likely that student will choose science related activities, persevere during those activities, put forth the needed effort to succeed, and ultimately experience success (Bandura, 1997; Britner & Pajares, 2006). Conversely, students' disbelief in their science ability promotes avoidance behavior (refusal to take science courses), decreases expended effort (when avoidance is impossible), and deepens feelings of stress and anxiety during science classes (Britner & Pajares, 2006). Additionally, students' self-efficacy has direct influence on their academic goals, high school and college course choices, and future achievement (Britner & Pajares, 2006). Because perceptions of capability affect perceptions of self within a domain, enjoyment of that domain, and perceived importance of that domain (Bong & Skaalvik, 2003), it has been argued that educators who want students to do well in science classes and choose science courses in the future, must make concerted efforts to encourage and improve students' science self-efficacy (Britner & Pajares, 2006).

School Transitions and Self-Efficacy

Berry and West (1993) posit that it is during times of change, uncertainty, ambiguity, and stress that self-efficacy judgments are ultimately made. Because of this, self-efficacy becomes especially vulnerable during times of transition (Bandura, 1997; Linnenbrink & Pintrich, 2003). Likewise, beliefs acquired during the early and intermediate years of development are not yet refined and are more susceptible to contextual influences, situational demands, and fluctuations in physical and emotional states (Bandura, 1997). Thus, it would seem that transitions made during the early to intermediate and intermediate to secondary years of schooling are especially important to the development and retention of self-efficacy. These transitions constitute major environmental changes for students (Bandura, 1997, Harter et al., 1992). Indeed, as students make these transitions through their school experience, a variety of contextual factors serve to influence, both positively and negatively, their academic self-efficacy.

During a child's formative years, the school serves as the primary setting for the development and social validation of cognitive capabilities (Bandura, 1997). Thus, as children learn to think of themselves as students and master various cognitive skills, they also develop a growing sense of their own intellectual self-efficacy (Bandura, 1997). However, even as students are developing academic self-efficacy, there can be some aspects of schooling that undermine the development of those beliefs (Bandura, 1997; Britner & Pajares, 2001; Harter et al., 1992). Usher and Pajares (2008) found that students' self-efficacy for self-regulatory skills, which related positively to science self-efficacy, decreased as students progressed through school. This decline in self-efficacy could be attributed to the fact that as students transition out of elementary school and progress through middle school and to high school they are held accountable for more of their own learning (Usher & Pajares, 2006). Therefore, unless self-efficacy is already strongly developed and rooted before the transition, students' self-efficacy beliefs may falter.

As students move from elementary school into middle school and from middle school to high school they not only make physical transitions, but there is also a shift in academic goals and priorities within the institutions themselves (Harter et al., 1992). In general, the school environment becomes more impersonal and achievement oriented (Harter, et al., 1992), with students often feeling a decline in the quality of student-teacher relationships (Eccles & Roeser, 2011). A social comparative emphasis is often adopted by the school, which results in the tracking of students, competitive grading, and a focus on assessment for performance rather than learning (Harter et al., 1992). Together, these changes have been shown to negatively affect students' perceptions of school and their motivation to learn (Harter et al., 1992), thus undermining their sense of academic self-efficacy (Bandura, 1997).

School transitions also bring with them social changes in peer-group relations (Bandura, 1997; Benner, 2011; Schunk & Meece, 2006). The transition to secondary schools usually introduces students to a larger, more diverse student body (Eccles & Roeser, 2011). This introduction can bring with it fears of bullying and school safety (Eccles & Roeser, 2011). There also seems to be more pressure put on students to fill social and gender role expectations (Lord, Eccles, & McCarthy, 1994). These added pressures, along with the physical and hormonal changes students are facing as they transition into adolescence, can be confusing, embarrassing, and even scary, affecting students' perceptions of themselves, their peers, and their school environment (Dworetzky, 1993).

Throughout these transitions, students are forced to reevaluate and reappraise their self-efficacy to accommodate the ever-changing academic, contextual, behavioral, biological, and social criterion that permeates their educational environment (Bandura, 1997; Berry & West, 1993; Wigfield et al., 2005). Much like institutional transitions, these social transitions have been shown to have detrimental effects on students who already have low academic perceptions of themselves (Harter et al., 1992) and may influence the science self-efficacy beliefs of different populations of students.

Summary

In sum, although there are many factors that affect students' science achievement, research suggests that science self-efficacy serves as one predictor of students' success in science as well as their motivation to engage in science activities and continue toward science careers. What is unknown, however, is whether students' science self-efficacy is impacted at key school transitions, and whether differing student populations are affected differently at these times of change. Of particular interest during the current climate of science for *all* individuals (American

Association for the Advancement of Science, 1990; NRC, 2012) are those students who are often marginalized in science, including females and minorities (NRC, 1996; Southerland, Smith, Sowell, & Kittleson, 2007), specifically Hispanics, as so little research has been conducted about them within science and in regards to their academic self-efficacy. With these thoughts in mind, the purpose of this study was to examine students' science self-efficacy at two key transition points in their schooling: the transition from elementary school to middle school and the transition from middle school to high school in order to describe science self-efficacy at these key school transitions for differing student populations, namely grade level, gender, and ethnicity.

Chapter 3

Methods and Procedures

The purpose of this study was to examine students' science self-efficacy at the transition from elementary school to middle school and the transition from middle school to high school and to compare those beliefs across grade level, gender, and ethnicity. This chapter describes the research design, setting and participants, data sources, data collection, and data analysis that were used in the study.

Research Design

This quantitative study employed survey research methodology (Gall, Gall, & Borg, 2003) in order to collect data about students' science self-efficacy. This research method was chosen for its ability to collect data on a range of variables that affect students' science self-efficacy beliefs and to examine the possible relationships among those variables among a cross-section of students within one school district (Glasow, 2005; Johnson & Christensen, 2004). Advantages of survey research include the fact that it can be used with representative groups of a given population, it is useful for gaining information on large numbers of the population, and for eliciting information about specific beliefs and attitudes that may be difficult to obtain through observation (Glasow, 2005).

Setting

Students who were asked to participate in this study were drawn from the Pioneer School District (a pseudonym), which is located in a midsize city in the western United States. This school district was chosen because of its accessibility and its pre-established relationship with the researcher's university. The school district has a fairly diverse population, including a large number of Hispanic students, which was of specific interest to the researcher given the research on marginalized groups in science (Southerland et al., 2007).

While every school district has its own way of organizing students and schools (e.g., elementary as K-6 or K-8; middle schools or junior high schools; high school as grades 9-12 or grades 10-12), this particular school district used the middle school model. Thus, elementary schools in Pioneer School District include grades K-6, middle schools include grades 7-8, and high schools include grades 9-12.

At the time of the study, the school district had approximately 13,000 students distributed into 13 elementary schools, two middle schools, two regular high schools, and two alternative high schools (high schools populated with students in grades 9-12 who are traditionally not successful in a large public school). Two elementary schools, one middle school, and one regular high school from the district were purposively chosen to participate in the study. This selection was based, in part, on the diversity of their student populations, with each school having at least 20% of its student body identified as Hispanic. This was done for this study in order to obtain data on this particular marginalized group of students. Additionally, these particular schools were selected because they comprise a unit, of sorts, within the school district, enabling the researcher to investigate a particular, representative population of students who attend elementary schools that feed into the same middle school, who then feed into the same high school. Thus, although this study is not a longitudinal study following a specific group of students to explore their science self-efficacy at the two transition points of interest in this study, it does offer a snapshot of the science self-efficacy of students from a very similar context. A description of each of these schools (identified by pseudonyms) at the time of the study follows and is summarized in Table 1.

Table 1

Participating School Demographics

	Adams Elementary	Taylor Elementary	Dalton Middle School	Pioneer High School
American Indian	1.1%	3.3%	1.2%	0.6%
Asian	0.9%	1.1%	0.5%	1.2%
Black	0.9%	1.1%	0.9%	1.0%
Caucasian	63.2%	41.0%	70.5%	74.3%
Hispanic	30.9%	51.0%	25.2%	21.1%
Pacific Islander	3.0%	2.4%	1.7%	1.8%
Free/Reduced Lunch	60.0%	72.5%	40.8%	30.4%
LEP	20.7%	43.1%	16.1%	12.1%
Migrants	0.0%	0.6%	0.4%	0.6%
Homeless	1.1%	2.2%	0.7%	0.6%

Participants

For this study, approximately half (46%, n=522) of the 1,126 students asked to participate gave assent and returned parental consent in order to participate in this study. There were 314 (60%) female and 208 (40%) male participants, with the majority of respondents being Caucasian (48%), followed by Hispanic (33%; see Table 2 for a full description of the sample population).

In Adams Elementary there were 69 sixth grade students. Of those, 50 students (72%) participated in the study. Taylor Elementary had 71 sixth grade students enrolled in the school; however, one of the sixth grade teachers at the school opted not to have his class participate in the study, leaving only 47 possible student participants. Of those, 33 students (70%) agreed to participate in the study.

Table 2

Sample Population

	Sixth Grade (n=83)	Seventh Grade (n=118)	Eighth Grade (n=166)	Ninth Grade (n=155)
Gender: Male	38	44	62	66
	(45.8%)	(37.3%)	(37.3%)	(42.6%)
Female	45	74	104	89
	(54.2%)	(62.7%)	(62.7%)	(57.4%)
Caucasian	29	60	102	71
	(34.9%)	(50.8%)	(61.4%)	(45.8%)
Hispanic	32	36	45	56
	(38.6%)	(30.5%)	(27.1%)	(36.1%)
Other Ethnicity	19	22	19	28
	(22.9%)	(19.0%)	(11.4%)	(18.1%)
Response Rate	71.6%	58.7%	37.3%	42.6%

Adams Elementary and Taylor Elementary are two of six elementary schools that feed into Dalton Middle School. Middle schools in Pioneer District include only the seventh and eighth grades. At the time of the study, approximately 402 students were enrolled in seventh grade. According to state requirements, seventh grade students register for one semester of science during the academic year. Because of this, the population sample was limited to approximately 201 seventh grade students who were enrolled in science classes that semester. From those students, 118 (59%) volunteered to participate. In contrast to the state requirement for seventh grade science, eighth grade students complete a full year of science. Thus, all 445 eighth graders were asked to participate. Of these, 166 eighth graders (37%) chose to participate.

Pioneer High School is a collector school for two middle schools, one of these being Dalton Middle School. Of the 364 ninth grade students who were enrolled in science classes the semester the study took place, 155 (43%) agreed to participate.

Data Sources

For the purposes of this study, a two-part survey was used (see Table 3). The first part of the survey collected data on students' sense of science self-efficacy through a modified form of the Self-Efficacy Questionnaire for Children [SEQ-C; Muris, 2001]. The SEQ-C is a 21-item scale designed to measure children's perceptions of their social self-efficacy, emotional self-efficacy, and academic self-efficacy, aspects of students' identity that potentially impact their beliefs about their competency in school (Bandura, 1997; Muris, 2001; Suldo & Shaffer, 2007). Because scores are summed to yield a measure of self-efficacy for each domain separately, only those questions pertaining to academic self-efficacy were used for this study.

The SEQ-C was chosen for its reliability as measured by its internal consistency (Cronbach's alpha coefficient of .88 for academic self-efficacy), construct and criterion related validity (Muris, 2001; Suldo & Shaffer, 2007), and for its clear adherence to Bandura's guidelines for writing self-efficacy instruments (Bandura, 2006b). Although the SEC-Q was originally scaled for middle and high school students, the researcher felt confident that mid-year sixth grade students housed in elementary schools would have no problem understanding and completing the instrument given its short format and clear wording. Additionally, although the sixth grade students in this setting are housed in elementary schools, this age group is often included in some school districts across the United States as part of a middle school student population.

In order to measure specifically for science self-efficacy, modifications were made to the academic self-efficacy subscale, including slight word changes to accommodate for science learning (e.g., "How well can you study [science] when there are other interesting things to do?" On the modified version of the SEQ-C survey used in this study, students rated their beliefs about their science competence on a 5-point Likert scale (1 = not at all, to 5 = very well). See Table 3 for full list of questions.

Table 3

Modified SEQ-C with Demographic Information

1. How well can you study science when there are other interesting things to do?
2. How well can you study for a science test?
3. How well do you succeed in finishing all your science homework every day?
4. How well can you pay attention during science class?
5. How well do you succeed in passing science class?
6. How well do you succeed in satisfying your parents with your science schoolwork?
7. How well do you succeed in passing a science test?
8. Grade in school: 6 7 8 9
9. Gender: M F
10. Ethnicity: American Indian Asian Black Caucasian Hispanic Pacific Islander Other

The second part of the survey asked questions about the three demographic variables, allowing the researcher to collect data regarding the participants' grade in school, gender, and ethnicity. Students indicated if they were in sixth, seventh, eighth, or ninth grade, and whether they were male or female. For ethnicity, students were given seven categories to choose from: (1) American Indian, (2) Asian, (3) Black, (4) Caucasian, (5) Hispanic, (6) Pacific Islander, and (7) Other.

Data Collection

All students in the participating schools enrolled in sixth, seventh, eighth, and ninth grades were invited to take part in the study. These grade levels were selected because they represent significant transition points in students' school lives (i.e., transition from elementary to middle school, transition from middle school to high school; Harter et al., 1992). Data collection in all schools occurred during March 2012. A brief information letter that described the study, potential risks, and benefits was crafted along with forms requesting consent from parents and assent from students to participate in the study. Due to the demographic characteristics of the participating schools' populations, all letters and forms were in Spanish and English. The letter and the consent and assent forms were discussed with and distributed to the students by the researcher in students' science classes. Students were asked to sign assent forms in class that day and return signed parent consent forms within a week. A reminder was sent home midweek. Consent forms were turned in to the students' science teachers and picked up by the researcher the following week. The researcher provided a small incentive (a candy bar) to all students who obtained informed consent, which was distributed by their classroom teacher.

In the elementary schools, the researcher administered the instrument to students during class time during the school day. In the middle school and high school, the instrument was administered during students' regularly scheduled science classes. Most students took approximately five minutes to complete the 10-item survey. While all students within the classes surveyed who gave assent participated in taking the survey, only questionnaires of students who granted assent and whose parents gave informed consent were used in the final analysis.

Data Analysis

Multiple Ordinary Least Squares Regression (Hutcheson & Sofroniou, 1999) was used to analyze the relationship of grade in school, gender, and ethnicity on science self-efficacy. This approach was selected because it allows the researcher to identify significant predictive contributions made by each of the independent variables on science self-efficacy, the dependent variable. Further, one can observe any interactions between the independent variables. For this study two regression models were developed, one using ninth grade as the comparison group and the other using sixth grade as the comparison group. In each model, the independent variables were regressed on the dependent variable, self-efficacy.

For this analysis the three independent variables were organized for inclusion in the model: grade level, gender, and ethnicity. Grade level was coded into four dichotomous variables (0/1) where students were coded as "1" for the grade in which they were enrolled (e.g. sixth grade =1, not sixth grade = 0). Gender was coded as a dichotomous variable where female was coded as "1" (male = 0). Seven categories were available on the survey for students in selecting their ethnicity. Some students chose to circle more than one category to describe their ethnicity, an issue that was not anticipated by the researcher. This resulted in 21 possible ethnicity categories. In order to reflect overall distributions and to organize the data, the categories were collapsed to make three distinct ethnicity groups for this analysis. Students who only chose Caucasian were placed in the *Caucasian* category. Students who chose Hispanic as at least one of their ethnicity choices were placed in the *Hispanic* category. Students who chose any other combination of categories that did not include Hispanic were placed in the *Other Ethnicity* category (e.g. Black + Caucasian). This resulted in *Caucasian* making up 50.2% (n = 262) of respondents, *Hispanic* 32.4% (n = 169), and 16.3% (n = 85) were categorized as *Other Ethnicity*.

In looking at the demographic spread of the schools studied (see Table 1), the researcher felt these categories adequately reflected the population sample.

Preliminary correlation analyses were performed between the independent variables to check for independence. A significant correlation between *Caucasian* and *Sixth Grade* and *Caucasian* and *Eighth Grade* was found. *Other Ethnicity* and *Eighth Grade* were also found to be significantly correlated. Interaction variables were constructed to assess whether these interactions had an impact on the analysis. They were not found to be significant and were therefore removed from the final model.

Since the dependent variable for this analysis was science self-efficacy as measured by the modified SEQ-C. A principle components analysis was performed to confirm for this sample that the seven questions of science self-efficacy held together into one measure showing content validity for the modified SEQ-C used in the study. This variable was organized by scaling the seven questions on a 5-point Likert-type scale for possible scores in a range of 7 to 35 points.

Limitations

There are acknowledged limitations to this study. First, general limitations associated with self-report measures in analysis include validity threats due to inherent cognitive biases or deficits (Carter & Dunning, 2007; Dunning, Heath, & Suls, 2004), lack of self-knowledge, overconfidence in personal judgment and prediction (Dunning et al., 2004), and the assumption that the perception of the construct is an accurate reflection of reality (Davies, 2011). Another limitation could include the number (20%) of limited English proficiency [LEP] students in these schools. Their LEP status could affect comprehension of the instrument, which could skew the data if those students answered the questions without fully understanding them.

Confusion on the part of a few students was also observed by the researcher with the question regarding ethnicity. Although the researcher used the ethnicity categories employed by the school district and explained them fully, some students still showed some confusion when answering that question. For example, there were students who circled *American* instead of the entire phrase *American Indian*. Other students circled *Other* and then wrote in *Mexican*. Because of this apparent confusion, there may be a potentially small misrepresentation on the ethnicity numbers for some specific groups; however, based on the small number of these kinds of responses (fewer than 10 out of 522) and the fact that all ethnicity groups other than Hispanic and Caucasian were collapsed into *Other Ethnicity.*

There are limitations in terms of the generalizability of this study to other populations due to the fact that this study examined the science self-efficacy beliefs of students in one catchment area due to sampling limitations. Additionally, because the response rate was only 46% overall and varied across grade levels, the researcher recognizes that there may be selection bias as non-respondents may hold differing science self-efficacy beliefs than those students who chose to participate in the study.

Chapter 4

Findings

The purpose of this study was to examine students' science self-efficacy at two key school transitions: the transition from elementary school to middle school, and the transition from middle school to high school in order to describe science self-efficacy at those key school transitions for differing student populations, namely grade level, gender, and ethnicity. This chapter will discuss the results of the study by examining the effect each of the independent variables (grade level, gender, and ethnicity) had on reported science self-efficacy levels.

Regression Analysis One: Using Ninth Grade as the Comparison Group

Because the researcher was interested in studying science self-efficacy at the transition from elementary school to middle school and the transition from middle school to high school, information was gathered from sixth, seventh, eighth, and ninth grades; the grades in which transitions occur in this school district. Gender was also of interest because gender has been shown in previous studies (Pajares & Miller, 1994; Skaalvik & Skaalvik, 2004; Usher & Pajares, 2006) to be important to self-efficacy and science attitudes. Hispanic students' science self-efficacy was also important to the researcher because of the growing number of Hispanic students within the American school system and the lack of information available in the literature on their self-efficacy beliefs in science and in other areas of the curriculum. Both of these populations were also of interest in this study because they are considered to be underserved groups of students in science education today (NRC, 1996, 2012).

In the initial analysis, grade level, gender, and ethnicity were regressed on science self-efficacy scores. For grade level, *Ninth Grade* was used as the comparison group because it was initially assumed this grade would show the greatest variance in science self-efficacy beliefs. *Male* and *Caucasian* were used as the other comparison groups.

Overall model statistics showed that this model was able to explain about 14% of the variation in science self-efficacy scores in our sample. Additionally, this model was significant at the .000 level, suggesting that the included independent variables were relevant to self-efficacy. Specifically, grade level, gender, and ethnicity were significantly related to self-efficacy scores in this model and will be discussed in the following sections.

Grade level and science self-efficacy. Each of the grade levels included in the analysis were found to be significantly related to science self-efficacy outcomes. Using *Ninth Grade* as the comparison group, sixth, seventh, and eighth grades were significantly related to science self-efficacy scores. Specifically, sixth graders scored more than 3.6 points higher for science self-efficacy as compared to *Ninth Grade*. Interestingly, there appears to be a gradual decline in science self-efficacy as students move up in grade level. For example, seventh grade students scored lower (b = 3.32) on the science self-efficacy scale than the sixth grade (b = 3.64), with eighth grade students scoring over half a point (b = 2.76) lower than seventh graders and almost a full point lower than their sixth grade counterparts on the science self-efficacy scale as compared to *Ninth Grade* (see table 4 for full results).

Gender and science self-efficacy. In comparing female students' science self-efficacy scores to *Males,* their scores were found to be significant. Specifically, females scored almost a full point lower (b = -.89) than males on the modified SEQ-C. These scores were independent of ethnicity and grade level, suggesting that on average, female students in this sample have lower science self-efficacy than males.

Ethnicity and science self-efficacy. *Hispanic* students' science self-efficacy was found to be significant to science self-efficacy outcomes as compared to *Caucasians*, with *Hispanic* students scoring almost three points (b = -2.95) lower on the science self-efficacy scale than *Caucasians*. The science self- efficacy scores were independent of grade level and gender, suggesting *Caucasians* have higher science self-efficacy than *Hispanics*. Of note, *Other Ethnicity* was not found to be statistically significant to science self-efficacy scores.

Table 4

Multiple Regression Analysis for Science Self-Efficacy

Model Adjusted R^2	.142***			
Model F	15.358***			
Df	6,515			
	Analysis One		Analysis Two	
	B (SE)	B	B (SE)	B
Constant	24.908*** (.512)		24.908*** (.512)	
Ethnicity (Caucasian comparison)				
Hispanic	-2.950*** (.490)	-.260		
Other Ethnicity	-.504 (.619)	-.035		
Gender (Male comparison)				
Female	-.887* (.443)	-.082		
Grade				
Sixth Grade	3.645*** (.671)	.251		
Seventh Grade	3.320*** (.601)	.262	-.325 (.708)	-.026
Eighth Grade	2.758*** (.553)	.242	-.887 (.671)	-.078
Ninth Grade			-3.645*** (.671)	-.314

*<.05. ** .01. ***<.000.

Regression Analysis Two: Using Sixth Grade as the Comparison Group

After viewing the incremental decline of science self-efficacy scores as students moved up in grade level, the researcher became curious to examine the transition to ninth grade from another angle. As a result, an additional analysis was performed with *Sixth Grade* as the comparison group in order to look more closely at the science self-efficacy scores of ninth grade students. This second analysis used the same overall variables and looked at the same research question. However, by changing the reference category from *Ninth Grade* students to *Sixth Grade* students, the researcher was able to pin point the transition to ninth grade. In this analysis, only *Ninth Grade* students' science self-efficacy was found to be significant as compared to sixth grade. In this model, the effects of grade fall out for seventh and eighth graders, indicating that there is no significant difference between these grades and *Sixth Grade*. However, *Ninth Grade* students scored over three and a half points (b = -3.65) lower than the *Sixth Grade* students on the modified SEQ-C (see table 4 for a full list of results).

Together, these two analyses reveal the transition to ninth grade as the key transition for students in this sample. It appears that sixth, seventh and eighth grade students are significantly different from ninth graders in how they rate their science self-efficacy. While a gradual decline is seen from sixth grade to ninth grade, it does not emerge as statistically significant until the transition to ninth grade where the largest decline is seen.

Summary

This purpose of this study was to examine science self-efficacy at the transition from elementary school to middle school and the transition from middle school to high school to see if those transitions affected science self-efficacy. While no statistically significant effect was found at the transition from elementary school to middle school, a pattern was observed showing a steady decline in science self-efficacy scores with each grade level, resulting in a 3.6 point disparity between sixth and ninth grades. These results suggest that for students in this sample, science self-efficacy is not directly affected at the transition from elementary school to middle school; rather science self-efficacy decreases steadily as students move up through the grades. However, a large, statistically significant decrease in science self-efficacy scores was observed for ninth grade students, suggesting that science self-efficacy is indeed affected at the transition to high school.

The researcher was also interested in looking at science self-efficacy for specific student populations. Holding grade and ethnicity constant, females were found to have lower science self-efficacy than males, scoring almost a full point lower on the SEQ-C. Hispanic students were also found to have much lower science self-efficacy than Caucasian students, showing an almost three point disparity between the two ethnicities.

Chapter 5

Discussion

The primary purpose of this study was to examine students' science self-efficacy at two major transition points in their education: the transition from elementary school to middle school and the transition from middle school to high school to determine if students' science self-efficacy beliefs change at those key school transitions for differing student populations (grade level, gender, and ethnicity). What follows in this chapter is a discussion of the conclusions of the study, implications, and recommendations for future research.

Science Self-Efficacy and Grade Level

An apparent decline in science self-efficacy from grade to grade was found in this study, culminating in a 3.6 point deficit between sixth and ninth grade. Given the fact that the SEQ-C has a 7 to 35 point range, this disparity between the grades is quite large. These results are contrary to other studies on mathematical and verbal self-efficacy, which have been shown to increase gradually with age and grade (Zimmerman & Martinez-Pons, 1990). However, within science education research, these numbers follow trends of students' science competence (Beghetto, 2007), science attitudes, science self-concept, and beliefs about the utility of science that show a steady decline in these beliefs as students get older and move through the school system (George, 2000, 2006).

The results of this study also highlight the troubling trend in science education for instruction to become more dependent upon bookwork and theory, and, in many cases are taught more like language arts classes, with assigned reading, memorized vocabulary, and comprehension questions, rather than using true science inquiry as students move from elementary to middle school or junior high, and on to high school science classes (Britner &

Pajares, 2001; Osborne et al., 2003). This type of instruction diminishes the conceptual link science has to math and the naturally analytical, creative subject that it is (Britner & Pajares, 2001) and may make students feel less confident in their ability to succeed.

In contrast to this type of instruction, research suggests that in order for students to build and maintain science self-efficacy, they need to be actively engaged in science activities that promote ability and show the value of science (i.e. enactive mastery experiences; Lau & Roeser, 2002). This can be done by providing students with authentic science learning opportunities that use science inquiry to foster and promote accurate positive science self-efficacy (Britner & Pajares, 2006; Linnenbrink & Pintrich, 2003; NRC, 1996). These should be challenging academic tasks that are slightly above students' ability level in order to motivate, encourage persistence and effort, build success, and minimize failures (Bandura, 1997; Linnenbrink & Pintrich, 2003; Pajares, 2006). When science teachers give students the kind of mastery experiences that promote healthy development of self-efficacy such as hands on science courses, scaffolding, and inquiry based science investigations, they improve perceived science ability, achievement, as well as perceptions of science related careers (Britner & Pajares, 2006; Carter, Sottile, & Carter, 2001).

Science Self-Efficacy and Gender

That female students scored lower on the science self-efficacy scale than males in this study gives further evidence to an overall decline in attitudes and interest in science for female students as they get older (VanLeuvan, 2004). Perhaps even more alarming is that this research confirms the findings of previous research of an apparent trend for females to consistently score lower than males in terms of their self-efficacy in academic domains, such as mathematics and science (Beghetto, 2007; Pajares & Miller, 1994).

Although a key goal of science education is to provide equal access to science knowledge and to prepare *all* students for future jobs within science fields (Lau & Roeser, 2002; NRC, 1996; U.S. Department of Education, 2010), the results of this study suggest that female students may continue to be underrepresented in advanced science courses and science-related occupations. It has been shown that the stronger a student's academic self-efficacy, the greater interest they show in diverse occupations, the more career options they consider possible for themselves, the better they prepare themselves educationally for varying occupations, the greater staying power they have in challenging occupations, and the greater success they achieve occupationally (Bandura, 1993). Indeed, Brown and Lent (2006) cite longitudinal data that suggests pre-high school academic achievement is strongly linked to occupational aspirations of adolescents. However, there has been a steady decline in the interest to pursue scientific careers (see Osborne et al., 2003), particularly for girls between the seventh and twelfth grades (VanLeuvan, 2004), while the demand for more highly trained science and engineering professionals increases each year (NRC, 1996; Osborne et al., 2003).

Knowledge of how self-efficacy affects students' achievement and motivation in science, particularly for those students who may be marginalized in science, (e.g., female and Latino students) can be beneficial to classroom teachers seeking to improve science achievement and motivation for those students. A successful way to promote science and build science self-efficacy for females and students of other ethnicities is through mentoring and modeling. When teachers take the time to help students interpret their academic experiences, help them envision themselves in possible content areas (geologist, biologist), and guide them as they work to reach their goals, self-efficacy, effort, and achievement can be increased (Woolfolk Hoy & Davis, 2006). Also, when teachers provide appropriate peer or adult models that students feel they can relate to and emulate, both self-efficacy and performance is increased (Bandura, 1997).

Science Self-Efficacy and Ethnicity

In this study Latino students scored almost three points lower on the science self-efficacy scale than their Caucasian peers. Of interest is the fact that the only other studies this researcher could find on Latinos' self-efficacy beliefs found that they consistently had lower academic self-efficacy and experienced higher levels of apprehension (Pajares & Johnson, 1996) as well as lower science competence (Beghetto, 2007) than their Caucasian counterparts.

Because Latino students may be prone to higher anxiety in academic settings (Pajares & Johnson, 1996) as well as lower academic self-efficacy, classroom teachers need to work with students to provide the motivation needed and work to remove emotional fears, such as failure or anxiety (Schunk & Pajares, 2004). Often students struggle in school not because they lack the skills or intelligence, but because they believe they are incapable or they believe the coursework is irrelevant to their life (Schunk & Pajares, 2004). Classroom teachers can help students learn how to interpret cognitive and emotional information, make sure that those interpretations are adaptive, and identify and eliminate self-handicapping strategies by building self-efficacy (Pajares, 2006).

One way teachers can help students build science self-efficacy is by giving attributional feedback or feedback "that conveys information to students about what the [teacher] thinks of his or her [science] capabilities" (Schunk & Pajares, 2004, p. 130). This type of feedback allows teachers to give students the clearest information about their competencies for performing specific science tasks and achieving task success because it links performance with the attributions or perceived causes for success or failure. Attributional feedback improves self-efficacy because it acknowledges effort rather than ability, which gives credibility to the student that they are performing well in science due to their own hard work (Schunk & Pajares, 2004).

Recommendations for Future Research

This study emphasized the importance of transition points on students' science self-efficacy. Based on the findings, however, a gradual decline was seen from sixth grade to ninth grade, but it did not emerge as statistically significant until the transition to ninth grade, or high school, where the largest decline was seen. Perhaps subsequent studies could investigate schools that are structured differently than the ones used in this study. For example, if examining a school district where high school begins at tenth grade, would the same dramatic declines be seen in ninth grade or would they be postponed until tenth grade? It might also be interesting to examine additional grade levels to see if the decline begins earlier than sixth grade and continues to drop after ninth grade. Perhaps a qualitative longitudinal study would be beneficial to examine if specific students' science self-efficacy is affected at key school transitions over time and what contextual elements influence possible changes.

This research revealed lower science self-efficacy scores for ninth graders, females, and Latinos. Mixed methods research designed to examine if there is a cumulative effect on science self-efficacy for being a female Latino in ninth grade could shed light onto why these subgroups have lower science self-efficacy and how this affects their academic choices and success.

While this research focused solely on science self-efficacy, future research using the entire SEQ-C to examine if all types of self-efficacy, emotional and social, experience the same declines as academic self-efficacy over time, and particularly, if these types of self-efficacy are impacted by school transitions. Because of the nature of adolescence, emotional and social self-efficacy may see more of an impact as was found in a study by Wigfield, et al. (1991) which documented drops in self-concept for social ability at the transition to junior high school.

Also, how does science self-efficacy relate to general academic self-efficacy at these transition points? There is some evidence that students' attitudes toward science decline as they move through middle school and high school (Barmby, Kind, & Jones, 2008; George, 2000; Lyons, 2006). Yet, the work of Eccles & Wigfield (1992) indicated a general tendency for students' attitudes toward *all* school subjects to deteriorate during adolescence. What is the relationship between attitudes toward science and science self-efficacy?

Further exploration to examine the science self-efficacy of students of different ethnicities would also be beneficial to the literature. The student population in this study was predominately Caucasian and Latino, so it was difficult to measure the science self-efficacy beliefs of other groups of students. It would be beneficial to see if students of different ethnicities experience the same declines in science self-efficacy that was seen in the Latino and Caucasian students in this study. It might also be of interest if a similar study was conducted to see if Latino students in schools where they are in the majority, experience the same deficits in science self-efficacy as was seen here.

Finally, a study to look at poverty's effects on science self-efficacy would be of interest. The schools in this particular study identified approximately 51% of their student population as low SES as measured by students who qualified for free and reduced lunch, however, no question about socio-economic status was asked on the modified SEQ-C. Future studies examining a possible link between poverty and science self-efficacy would be beneficial to the literature on self-efficacy beliefs.

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