The Impact of the Middle School Transition on the Science Achievement Gap

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The science achievement gap in the U.S. has been in the spotlight for over a decade. American students lag behind their peers internationally in science and math. Results from the most recent National Assessment of Education Progress indicated that 32% of eighth-grade students performed at or above proficient levels in science (National Center for Education Statistics, 2010). There is a growing body of research on factors that are linked to science achievement. Yet there are few consistent and robust findings on factors that are linked to science learning and contextual factors that are related to science achievement (Mo, Singh, & Chang, 2013). Science achievement in middle school is a critical time for students to develop a strong understanding of and appreciation for science, yet science education in the United States is in crisis (Mesa, Pringle, & King, 2014). Earlier research on science achievement only focused on cognitive issues such as abilities, IQ, and other measures of innate aptitude. Later research, however found that IQ, only explained twenty-five percent of the variance in achievement levels (Jensen, 1998). The middle school years are increasingly viewed as a salient period of human development. Adolescents are transforming both mentally and physically. There is a cognitive shift in thinking. It is during this time that adolescents, are seeking to identify their own interests and abilities. The degree of success in coping with the transition from elementary to middle school, a bridge between preadolescent and adolescent development, influences student's attitudes and their academic success (Reynolds, 1991, p.1). This article analyzes different variables that may contribute to the decrease in science achievement as students transition from elementary to middle school. The variables are student self-efficacy, teacher self-efficacy, science literacy, interest, and attitude. Although there are demographic variables that may play a role in a student's academic achievement, the only variables analyzed in this article are school-based.

Student Self-Efficacy

A student's confidence level seems to decrease as they enter middle school. The class sizes are larger in middle school than they are in elementary school, the teacher-student ratio is greater, and the secondary textbooks are dense and abstract. These factors play a role in the student's self-efficacy. The concept of self-efficacy was introduced by Bandura (1997) and defined it as the "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p.3). According to Schunk (1985), self-efficacy serves as a moderator between a student's abilities and academic performance in that they will avoid academic tasks in which they lack confidence and choose those in which they will be successful. Students that have performance avoidance goals tend to have lower self-efficacy and show less challenge-seeking behaviors and intrinsic value for learning (Elliot, 1999: Hidi & Harackiewicz, 2000; Middleton & Midgley, 1997; Pajares, Britner, & Valiante, 2000; Pintrich and Schunk, 2002; Skaalvick, 1997). Students that have high goals tend to have higher self-efficacy, positive patterns of learning and higher achievement (Middleton & Midgley, 1997; Midlgley & Urdan, 1995; Pajares, Britner, Valiante, 2002). When a student is successful in completing a task their confidence and self-efficacy increases. However, just the opposite happens if they fail. As Bandura asserts, failures tend to weaken one's beliefs about one's capabilities to perform well especially when a failure occurs before a strong sense of self-efficacy is established. The research focused on students beliefs have considered different facets of perceived self-efficacy for academic achievement (Bandura, Barbaranelli, & Pastorelli, 1996; Pastorelli, Caprara, Barbaranelli, Rola, Rozsa, & Bandura, 2001) which refers to: perceived ability to successfully master specific academic subjects and curricula and the perceived ability to regulate one's own studying and

learning activities. Verbal or social persuasion can also influence a students' self-efficacy. Middle school students care about what others think and say about them. Students' with a lack of self-evaluation of personal performances are likely to rely on the judgments of others to form their self-efficacy beliefs (Usher and Pajares, 2006). According to Bandura, sometime verbal persuasion hurts individuals' efficacy because it is easier to diminish the self-efficacy beliefs of individuals than to enhance them. Additionally, verbal persuasions may not have long lasting effects and may increase self-efficacy only for short periods of time (Usher, 2009). Although both verbal and social persuasions influence a student's self-efficacy, social persuasion alone does not yield a positive sense of self-efficacy (Britner and Pajares, 2006). In a school setting, teachers have the most influence on a student's self-efficacy.

Teacher Self-Efficacy

Teaching practices are key variables that may affect student achievement. Woolfolk Hoy and Davis (2006) link teachers' sense of self-efficacy regarding their subject, teaching strategies, classroom management, and relationship with students to student outcomes including student self-efficacy, motivation, and achievement. The teachers that are secure in their pedagogical knowledge display confidence in their instruction. Teachers' with high self-efficacy engage instructional practices that integrate higher goals and expectations, interest, and engagement with subject matter, responsibility for student learning, and creativity in the delivery of subject matter and student deliverables. Ultimately, an efficacious teacher incorporates student choices, delivers feedback to students, and encourages warm and caring interactions (Bolshakova, Johnson, and Czerniak, 2011). In addition, high teacher self-efficacy is considered an important factor in successful implementation of differentiation of instruction, difficulty of task selection, and student motivation, and positively affects teachers' beliefs about students, teaching and instructional behaviors (Klassen, Tze, Betts, & Gordon, 2011; Tschannen-Moran & Johnson, 2011; Tschannen-Moran & Woolfolk Hoy, 2001). Effective teachers continuously enhance their teaching strategies through life-long learning to stay motivated and to motivate their students.

Interest

According to John Dewey (1913), interest is the driving factor behind most learning behaviors, and modern researchers today have proposed that interest is the precursor for motivation. Interest is an important variable in adolescents' educational success. In science education, the role of interest has been widely studied during recent decades (Krapp & Prezel, 2011). McDermott (1981) reported that education of adolescents must begin with a psychological insight into their capacities, interests, and habits. These characteristics are important to middle school students. Interest is multidimensional, having both cognitive and affective dimensions (Krapp, 2002; Hidi & Renniger, 2006). Interest is known to be an important internal factor that influences learning. Personal interest is linked to one's internal motivations (Ryan & Deci, 2000). Hidi and Renninger revealed that students often enter middle school unmotivated and without an interest in science. In general, interest is understood as a relationship between an individual and an object (Krapp, 2002). An object refers to specific things in education such as topics and subjects. Interest can be understood as individual or situational. Individual interest is internal and stable, and it develops gradually. Situational interest is external, appearing as a response to something interesting in a person's environment (Krapp, Hidi, & Renninger, 1992). An individual's interest in science can be limited to a particular school subject (e.g., biology) or to specific topics and activities within a subject domain (e.g., acquiring knowledge about the structure of the human brain), a discipline (e.g., physiology), or a research field (e.g., ocean research) (Krapp & Prezel, 2011, p. 32). Interest, just like attitude is not static. Both interest and attitude depend on the course of study and the time. An example is a student having trouble comprehending the more advance sciences so his/her interest and attitude shift.

Science Literacy

Literacy in the secondary content area is complex and dense compared to elementary. For students to be successful in science, they must first understand science literacy. The United States is losing ground compared to other nations in science literacy (U.S. Department of Education, 2011). In every discipline, including science, literacy is an essential 21st-century competency. If students are to become productive world citizens, they need to be proficient oral and written communicators. Low science literacy is not only an educational issue but also an economic problem in the United States. The rapid growth of information has impacted the significance of literacy as part of economic and social participation (Carnavale, 1991). The rise of the relationship between education and income is evident in the increased amount of literacy in the workplace (Arc, Phillips, & McKenzie, 2000; Barton & Jenkins, 1995). Across the United States, science achievement is low. Eighty-two percent of our nation's twelfth graders perform below the proficient level on the 2000 National Assessment of Educational Progress (NAEP) science test. According to the U. S. Department of Education, "The longer students stay in the current system the worse they do. According to the 1995 Third International Mathematics and Science Study, U.S. fourth graders ranked second. By the twelfth grade, they fell to 16th, behind nearly every industrialized rival and ahead of only Cyprus and South Africa" (U.S. Department of Education). In the Nation's Report Card (NCES, 2006), comparative science achievement showed that national science literacy has been declining since the early 1990's, with little or no improvement in closing the achievement gap. At the same time, many other countries, particularly Asia, have been advancing their science literacy and consistently have outranked the United States in student science achievement over the past two decades (U.S. DOE, 2011). Such a decline is alarming, since a strong academic background in science has been identified as essential to national economic success (National Science Teachers Association (NSTA), 2005), as well as to addressing world issues such as global climate change, energy shortage, human population growth and advances in medicine (Olson, 2009; NSTA, 2005; Wagner, 2008).

Attitude

Students tend to have a positive attitude towards learning when they feel support from their teachers. Students that feel supported socially by teachers exhibit a greater likelihood of complying with teachers expectations, which reduces the likelihood that these students will engage in distracting and deviant behaviors (Hamre & Pianta, 2001). Koballa and Glynn (2007) refer to attitude towards science as either a positive or a negative feeling. Research shows that middle school students who maintained positive attitudes toward academics were significantly influenced by their parents/guardians, teachers, other family members and peers; however ,it was the teacher who most influenced student's attitudes towards science (Fredriksen and Rhodes, 2004; George, 2000; Gibson and Chase, 2002; Harris and Alexander, 1998; Kerka, 2000; Linder, Wingenbach, Harlin, Lee, Jackson, Johnson, Klemm, Hunter, Kracht, & Kochevar, 2004); Ma and Ma, 2004; Ma and Wilkins, 2002; Xu, 2004). Simpson, Koballa, Oliver, & Crawley, (1994) and Koballa and Glynn (2007) found significant relationships between student achievement and attitude toward science. One explanation for this relationship may be the well-established importance of task value to learning achievement (Ricco, Pierce, & Medinilla, 2010). It has been shown that teacher practices and student attitudes are directly correlated. For example Odom, Stoddard, & LaNasa (2007), found that seventh-grade students' attitudes toward science were positively associated with student-centered teaching practices and negatively associated with teacher-centered teaching practices.

Conclusion

The science achievement of U.S. students has attracted the attention of researchers, educators, policy makers and the general public. Due to the science achievement gap during the transition from elementary to middle school, districts needs to identify impediments concerning science reform. Middle school is a pivotal point in developing an

interest in science. Many school-based variables contribute to a student's loss of interest as they transition to middle school: student self-efficacy, teacher self-efficacy, science literacy, interest, and attitude. Each variable needs to be addressed in detail to improve educational policies that focus on improving science education. Despite the many variables that contribute to student achievement, Mo, Sigh, & Change (2013) conclude that more research on classroom teaching in science and student engagement in learning and achievement will help illuminate this significant educational topic for students and the country educational institutions.

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