EFFECTIVE INSTRUCTIONAL PRACTICES IN

SCIENCE FOR LATINO STUDENTS

by

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DISSERTATION APPROVAL

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ABSTRACT

This research documented the progress of physical science learning by Latino students with a range of backgrounds, language, and academic skills. Participants were stratified through an ordination analysis designed to identify individuals with stronger and weaker science vocabulary skills. Students in five different physical science classrooms eventually participated in the research. The investigation was conducted as a case study involving 16 Latino high school students. A variety of different forms of instruction were used by the participating physical science and chemistry teachers. Forms of instruction perceived to be effective were identified through student interviews and formative assessments.

Results indicated all participants perceived lecture-style instruction with adequate time to write notes and reflect on learning to be most effective. Latino students with weaker science vocabulary skills also perceived as being effective, collaborative work in which they were provided time to process the language of science and explore higher level concepts through discussions with peers.

Implications of the findings impact two areas of physical science instruction. First, when teachers were able to transfer power to students through classroom activities designed to accommodate heritage language and prior life experience, Latino student learning was enhanced. Second, providing temporal flexibility for instructional schedules resulted in more time to process language and improved content

understanding. Educators can be the directing force to eliminate the achievement gap if instructional time is allowed to vary based on student needs. When time was not a constraint on learning, all students, regardless of ethnicity, cultural background, or language learned the content.

While the students' perception of effective instruction was a lecture-style approach, this may reflect that students' perception of success was defined by assessments containing few requirements for creative thought or demonstration of problem solving skills. Students generally recognized the benefits accrued through high quality forms of instruction, including inquiry activities. Students and teachers recognized science education must be more than the recitation of facts and should develop skills for collaboration, problem solving, and creative interpretation of observations.

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DEDICATION

To the Latino students who persevere and succeed in spite of the obstacles within the education system.

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CHAPTER I

INTRODUCTION

The Proficiency Gap in Science

The school year started with the promise of a new beginning. Six high school teachers met in a conference room to discuss the results of the most recent state-mandated science proficiency tests. The pages of data represented the culmination of 2 years of instructional effort on behalf of the three physical science and three biology teachers. As they scanned the list of student names, the teachers reflected on the struggles and successes they shared with each other and with their students. The physical science teachers recounted the new inquiry activity they designed and the celebration of success when the students appeared to master the concept of thermal mass. The biology teachers shared their accounts of student exploration and discovery during the spring field trip to a local wetland. Although the shared experiences evoked a sense of accomplishment, the pages of assessment data imposed a different reality. The standardized test scores indicated only one out of every five twelfth grade students met the national benchmark in science (21%) (National Center for Education Statistics [NCES], 2011). As the teachers attempted to rationalize the results from the tests, they knew it was time for a new direction.

The lower than expected proficiency demonstrated on the science tests provoked questions among the teachers. They wondered how proficiency scores reflected the academic achievement of their students. They wondered why instructional practices, directed at academic achievement, were not reflected in the standardized scores. The teachers also wondered why their instructional practices resulted in high scores for some students while other students failed to master the content.

Proficiency Compared to Achievement

Standardized proficiency data became more visible during the past decade while other measures of academic achievement were minimized (Dahlin & Cronin, 2010; Shepard, 2010). Traditionally, classroom educators emphasized academic achievement associated with what was referred to in Bloom's Taxonomy as higher-order thinking skills such as analysis, synthesis, and evaluation (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956). The specific education goals were typically established by the classroom teacher. However, in recent years, standards have been defined by governmental agencies, including the acceptance by states of the Next Generation Science Standards (National Research Council, 2012, 2013) and proficiency became aligned with performance on standardized assessments (Barnes, Clarke, & Stephens, 2000; Barton, & Coley, 2009; Dahlin & Cronin, 2010). This emphasis on standardized assessment changed the definition of achievement as well as how classroom instruction is conducted.

Instructional practice became oriented toward what Bloom et al. (1956) described as lower-order thinking skills such as knowledge, comprehension, and application (L. W. Anderson & Krathwohl, 2001; Sultana, 2001). There was a reduced focus on creativity, problem-solving, and inquiry, which were skills Bloom et al. typically associated with higher-order thinking (American Association for the Advancement of Science [AAAS], 2007; Foster, Sultan, Devaul, Okoye, & Sumner, 2012). In addition, what used to be perceived as an academic achievement gap among different ethnic groups of students was transformed into a proficiency gap as defined by differences in standardized test scores which tended to focus on proficiency rather than content mastery.

Proficiency Test Results

The results discussed by the teachers were not unique among public schools participating in the 2009 and 2011 National Assessment of Education Progress (NAEP) science proficiency tests. Evaluation of the twelfth grade science scores at the state level demonstrated that in 2009 there were only five states where more than 40% of students assessed were proficient (i.e., Massachusetts, Minnesota, Montana, North Dakota, and South Dakota; NCES, 2011). By 2011, these same five states, as well as four other states (Colorado, New Hampshire, Utah, and Vermont), had more than 40% of the eighth grade students attain proficiency in science (NCES, 2012). In both 2009 and 2011, no state exceeded 44% of students attaining proficiency. In 2009, five states failed to have more than 20% of students proficient in science. These states were Alabama, California, Hawaii, Louisiana, and Mississippi. By 2011, Mississippi was the only state where fewer than 20% of eighth grade students passed the science assessment.

Proficiency on both the 2009 and 2011 National Science Assessment (NCES, 2011, 2012) varied by student race and ethnicity. This gap in proficiency identified that some ethnic groups, including White and Asian students scored significantly higher than Latinos (NCES, 2011, 2012). Throughout this study and the NCES research (Aud et al., 2012), the term Latino is used to refer to those individuals who self-identify as being “a person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race” (para. 3). Although Comas-Díaz (2001) recognized the concept of self-identity for the group of people discussed in this study as *Latino* is complex, this study will retain the definition of the term Latino established by the federal Office of Management and Budget and used in NCES documents.

The difference in achievement among racial and ethnic groups of students on the national assessment was significant based on results from testing of secondary students. The average score in 2009 for students in twelfth grade was 19% higher for White students than for Latino students. Similarly, the 2011 White eighth grade students scored 19% higher on the science assessment than Latino students. African American and Latino students tested in 2009 scored below the national average, with only 4% and 8%, respectively attaining proficiency in science (NCES, 2011). Scores achieved on the 2009 assessment did not vary significantly from those reported in earlier years (i.e., 1996, 2000, and 2005). Examination of data at individual schools indicated that the gap in science proficiency between Latino and White students was persistent even for groups of students in the same classroom. These data reinforced findings from Judson (2010), Stedman (2009), and Wei (2012) which suggested that recent federal school reforms such as No Child Left Behind and Race to the Top have not resulted in improved academic achievement for Latino students (Stedman, 2009). This stagnation in achievement for Latino students is a reflection of the lack of effective instruction (Berry, Daughtrey, & Wieder, 2009; Gandara, 2010; Ochoa, 2007). The concept of *effective instruction* is defined as those instructional practices that minimize the time required for the student to master academic content.

Power Structures in Education

Across the nation, students, science teachers, parents and administrators are frustrated by the persistent difference in learning outcomes in science education among ethnic groups (Becerra, 2012; Bernhardt, 2009; Figlio, Rouse, & Schlosser, 2009; Gandara, 2010; Gandara & Contreras, 2009; Madrid, 2011). Innovative researchers and teachers who understand the importance of science education strive to improve the effectiveness of instructional practices for diverse students (Bayer Corporation, 2012; Martinez, Lindline, Petronis, & Pilotti, 2012; Suriel, & Atwater, 2012). While some seek to improve comprehension and retention of science content, others direct their efforts at the identification of sociocultural factors leading to lower academic proficiency. The search for causative factors has led researchers to a range of systemic societal factors including, power that could influence the outcome of instruction (Bayer Corporation, 2012; Johannsen, Rump, & Linder, 2013; Rushton & Criswell, 2013; Seymour, & Hewitt, 1997).

There are two aspects of power over curriculum teachers are able to control within the science classroom. These include the scope and sequence of the curriculum and the development of lessons used in the classroom. Through control of these components of instruction, teachers are empowered to improve the effectiveness of instruction for Latino students, including those with limited English proficiency.

While science teachers have power to improve instructional practices and present effective instruction for all students, teachers also have the opportunity to exercise coercive power. An example of a coercive use of power occurs when a science teacher establishes a policy in which students are prohibited from participating in a laboratory activity without reading a technical pre-lab questionnaire (Seymour, & Hewitt, 1997). This practice is widespread among secondary and post-secondary science courses. This includes courses at University of Wisconsin (2013) and University of Kansas (2013). Other institutions emphasize a thorough class discussion with accompanying assignments as a means to prepare students for a laboratory activity (University of California Berkeley, 2013; Vanderbilt University, 2013). The decision by the teacher to employ pre-lab assessments disempowers students with limited academic science language as well as those with limited English language proficiency. If the student cannot read or understand the questionnaire, they will not be able to participate in the learning activity. As with other disempowering actions, students become accustomed to not participating in classroom activities. This then has a negative impact on student acquisition of science content knowledge (Bruna, Chamberlin, Lewis, & Ceballos, 2007; NCES 2012). Conversely, science teachers can have a positive influence on students when they convey the message that all students are capable of learning science regardless of their level of language proficiency (Heilbronner, 2013; Mason, Boscolo, Tornatora, & Ronconi, 2013; Peters-Burton & Hiller, 2013).

For Latino and other marginalized students, empowerment also occurs when teachers include the cultural background of students in class discussions and activities (Chigeza, 2011; Meyer & Crawford, 2011; Saifer, Edwards, Ellis, Ko, & Stuczynski, 2005). By considering how power affects student engagement and performance, teachers have the opportunity to influence the effectiveness of instruction (Dakers, 2005).

Power structures in a science classroom can influence the effectiveness of student learning and can therefore serve as a potential source of the observed gap in science proficiency. For Latino students, demonstrations of power by students and teachers can impact learning in a variety of ways, including whether students serve as passive or active learners. Freire (1993) suggested that students are often expected by teachers to behave as passive learners, waiting and anticipating the receipt of information from instructors. This teacher-centered model assumes that students have no worthwhile contribution to make in the classroom (Sweeden, 2011). Freire questioned the teacher-centered model suggesting that students should be active learners, questioning teachers as well as the content and assumptions associated with the lessons presented by the teacher. This exhibition of student-based power in the classroom can present an uncomfortable challenge to the existing teacher-centered power structure (Davila & Aviles, 2010). The interplay of these power structures between teachers and students can impact Latino student proficiency in science, as defined by state and national standardized assessments.

Statement of the Problem

Although all students ought to be able to perform well in science classes regardless of race or ethnicity, the results of national and state proficiency assessments indicate that in the current instructional environment, science proficiency is not similar among racial and ethnic groups of high school students. There have been three primary explanations for this phenomenon. The first explanation for the achievement gap focused on deficit theory. This was predicated on the assumption that culture and language placed Latino youth in a position where they were not as capable of understanding science as White or Asian students (Arlin, 1984; S. Brown & Souto-Manning, 2008; Eysenck, 1971; Gonzalez, 2005; Huerta, 2002; Schultz & Hull, 2002; Wallace & Brand, 2012; Watterman, 2008). A related deficit construct recognized as oppositional culture theory (Ogbu, 1978) assumed that marginalized students purposefully achieved low scores on standardized assessments to minimize conflicts with peers regarding academic performance. Subsequent investigation of this theory has discounted its validity (Diamond, 2006; Fryer, Roland, & Torelli, 2010; Harris, 2006; Horvat & O'Connor, 2006; Sohn, 2011).

The second explanation for the achievement gap focuses on sociocultural factors that are generally accepted as being beyond the influence of classroom teachers. Sociocultural factors are generally discussed as a function of school and