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The relationship between learning style preference and achievement in the adult student in a multicultural college.

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COLLEGE OF EDUCATION

This is to certify that the doctoral study by

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and that any and all revisions required by
the review committee have been made.

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2008

ABSTRACT

The Relationship Between Learning Style Preference and Achievement in the Adult Student in a Multicultural College

by

Matilde E. Roig

MST, Rutgers University, 1978
BS, Upsala College, 1976

Doctoral Study Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Education

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August 2008

ABSTRACT

Minority college students have varied learning styles and process information from distinct background and cultural perspectives, which influences their learning. Accordingly, the way faculty approach teaching affects student achievement. Few minorities are in scientific fields, with a shortage of scientists predicted. A problem exists in understanding the relationship between learning style preferences and achievement of minority college students. The purpose of the study was to investigate this relationship in adult minority students in a South Florida college's biology courses. Research questions pertained to relationships between learning style preferences, race, ethnicity and grades. This quantitative study used the online Felder-Soloman Inventory of Learning Styles with a 73% response comprised of 162 White, Black-African American, Hispanic, and Asian students. Variables included grades, race, ethnicity, and learning styles**.** Relative frequency analysis revealed students preferred sensing, visual and sequential learning. ANOVA analysis showed no significant differences between learning style preference and achievement, nor between race-ethnicity and grades. Chi-square analysis revealed a significant relationship between Black-African Americans and Hispanics for sensing, visual and sequential learning, but not for visual. Black–African American students had the lowest passing rate in biology courses, with Asians having the highest. Increased educator and advisor knowledge of learning styles could result in social change and educational reform from this study, through the adoption of best methods for teaching minority groups enrolled in science courses. Knowing the potential shortage of minorities in the sciences, increased achievement in science courses might encourage these students to enter into scientific careers.

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DEDICATION

I dedicate this doctoral study to my father and mother, Carlos and Matilde, for their endless belief in me, and for instilling in me the value of education, ethics, and giving. I also dedicate this to Steve, for through his love, I have been able to achieve a dream in my education and in my personal life.

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I want to acknowledge my life partner, for his constant love and countless hours of support while I typed. Also, this study would not be possible without the support of my dearest friends, Lyn and Peggy, who have seen me through many things in life and have been there to push me to new limits. Their encouragement has allowed me to believe that I could accomplish this study and endeavor. In addition, Jeanne, Irmgard and Greg were constantly in my heart and mind.

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I also want to thank the faculty and students who participated in this study, as well as those who will participate in future studies to improve education and life amongst minorities and for all students. Last, but not least, I want to thank my children, Karl, Tristan, and Irina, for they have been a joy in my life and a reminder that I, as their mother, should continue to be a role model. I thank them for the chance to instill in them the joy of learning and the joys of loving.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1:

INTRODUCTION TO THE STUDY

Introduction

Students have varied learning styles, which are characterized strengths and preferences in the ways that they process information and learn. Culture, which influences the manner information is processed (Tsui, 1996), also influences learning style preference more so than other factors (Sauceda-Castillo, 2001). This study was designed to examine the relationship between learning style preference and achievement in the adult student in a multicultural college. Students under consideration for this endeavor were Hispanics, Blacks, and other minorities.

Educators have observed that some students prefer certain methods of learning more than others (Diaz & Cartnal, 1999) and, in particular, that different minority groups have varying learning style preferences. Studies on minority students and their learning styles (Baumgartner, 2001; Claxton & Murrell, 1988) including African, Asian, and Hispanics found differences in learning style preferences (Dunn, et al., 1990). A concern in education is that of increasing diversity in the classroom. Diverse student populations also need to be considered because diversity is posing greater challenges on instruction (Anderson & Adams, 1992). Torres and Cano (1994) stated that "because learning style affects the learning success of students in specific kinds of situations, instructors need to be sensitive to learning style difference. Instructors should have insight of students' preferred learning style" (p. 64).

Culture is a way of life and a way in which individuals adapt to situations based on their background. Culture conditions people's thoughts about the natural world, the

environment, and understanding. How people think and understand is influenced by their particular culture and these influences cannot be removed from an individual's way of thinking. Culture is the total way of life of a people who incorporate social and economic relationships, such as family and its influences (Dunn & Griggs, 1996). Bruner (1996) discussed how cultural psychology examines how individuals make sense of the world and how they engage with established systems. Because students of difference cultural backgrounds are living in an environment that is different from their home country, these environmental factors influence how they feel in a particular setting. Markus and Kitayama (1991) stated

> People in different cultures have strikingly different construals of the self, of others and of the interdependence of the two. These construals can influence, and in many cases determine, the very nature of individual experience, including cognition, emotion, and motivation. (p. 230)

The researcher's interest was in adult learners, specifically minorities and how learning styles correlated to achievement. Research on culture and its influence on learning discuss how culture and core curriculum, as manifested in multicultural education, are influenced (Banks, 2006; de Vries, 2005; Ogbu, 1992). Wang, Haertel, and Walberg (1997) discussed how educational strategies used to improve adult student learning can be used to provide ideas and considerations for forming educational practices. What gives meaning to people will influence decision making. In addition, what has shaped a person's way of thinking provides the basis for understanding how that person accepts and rejects criteria. Hodges (1988) stated that it was important to know the learning styles of students to assist them in being able to achieve in their studies. If

preferred learning styles are known for various minority groups, then specialized teaching techniques can be applied to these students, thereby improving achievement.

Background

Minority groups are almost nonexistent in science and engineering departments in research universities (Nelson & Rogers, 2006). In addition, minorities do not traditionally enter scientific careers. They are underrepresented as faculty in the university system, as well as in research and development (USDA, 2005, 2006; National Science Foundation Indicators [NSFI], 2006). The NSFI is a record comprising the major high-quality quantitative data on the U.S. and international science and engineering enterprise. According to the NSFI, the percentage of all science and engineering degree holders in the labor force who are age 50 or over is 29%. Among science and engineering doctorate holders in the labor force, 44% are age 50 or over. What this indicates is that within the next 15-20 years, almost half of the science workforce will be retiring. The USDA, who is the leading employer of scientists in the United States, issued the Agricultural Research Station 2006-2010 Workforce Plan Report (ARS, 2006), which indicates that at least 25% of the scientists will be retiring in the next decade or two. Collectively, minority groups (Hispanics, African-Americans, and other ethnic groups) constitute 24% of the total U.S. population, 13% of college graduates, and 10% of the college-educated population in science and engineering occupations. The National Science Foundation Science and Engineering Indicators (NSFS&E, 2006) report stated

> The representation of blacks in science and engineering occupations increased from 2.6% in 1980 to 6.9% in 2000. The representation of Hispanics increased

> from 2.0% to 3.2%. However, for Hispanics, this is proportionally less than their increase in the population. (p. 4)

The indications are that few minorities are in the science and engineering workforce and the current chance of those numbers increasing is slight.

In addition to there being a shortage of minority faculty and scientists, a shortage of minority teachers in the K-12 grade levels also exists with the greatest shortage in science and mathematics (Clark, 1999). Various studies, commissions, and national reports on teacher supply and demand have concluded that teacher shortages in mathematics and science are considerable (American Association for Employment in Education [AAEE], 2003; National Commission on Teaching and American's Future [NCTAF], 2003). Low minority representation exists in science education, as well as in scientific research. A National Science Foundation Workshop Report (January, 2005) stated that

> The members of groups under-represented in STEM careers, including women, African Americans, Latinos, Native Americans, and persons with disabilities, face multiple and reinforcing obstacles if they choose to pursue these professions. Though many of these individuals have the greatest educational needs, they tend to be the least well served by the K-12 educational system. (p. 1)

White majority educators in sciences and other fields teach from their own perspectives. How teachers view others and interpret experiences, relationships, and ideas is based on race and culture (Kendall, 2006). In multicultural schools, teachers with their own ethnocentric views may approach students without considering the students' cultural makeup. Lack of access to good schools with resources and teachers qualified in science and mathematics are common problems that minority students encounter (Oakes,

Ormseth, Bell, & Camp, 1990). This lack of access decreases opportunities for minority groups' achievement in these areas.

In the Bureau of the Census Current Population Survey Report (1999–2001), the projections show that minorities (Asians-Pacific Islanders, Blacks, Hispanics, and American Indians-Alaskan Natives) are expected to be more than half (52%) of the resident college-age (18-24 years old) population of the United States by 2050, up from 34% in 1999. The greatest projected growth is in Hispanics and Asians, reflecting immigration trends with little growth for college-age African Americans. Ogden, Ogden, and Schau (2004) reported that the U.S. Census Bureau (2003) has listed Blacks, Hispanics, and Asians as the fastest growing minority groups, with Hispanics being the largest.

Enrollment figures show that underrepresented minorities in higher-education institutions comprise 10.4% of the total student population of college students, with only 7.5% of these students earning doctorate degrees in any field (NSFS&E Indicators, 2006, Appendixes 2-5). Although these statistics are for overall fields, the proportion of students in the sciences is, therefore, even less. Concern in the scientific community exists regarding not only retiring scientists in the future workforce, but also low minority representation in that area, including in higher education.

Minorities are underrepresented in science and math from elementary to graduate school. Clark (1999) stated that "lack of preparation in science among underrepresented minority groups in the early elementary grades undermines enrollment and success in secondary-level school programs, and ultimately, in college and career choices later in life" (para. 2).

Proper preparation in the sciences can enable students to prepare themselves for careers in a technologically driven society (Clark, 1996). Adequate preparation applies to all students but in particular to minority groups who do not usually enter these fields. The potential crisis anticipated in scientist shortfall can be addressed by acknowledging that minority groups should be encouraged to enter scientific fields, including teaching in the sciences. By reaching out to minorities the educational system may be able to fill the gap in the areas that will be affected in the next decade. If the pattern of demographic growth continues, in about 20-30 years, the number of children in elementary schools will be about equally split between Whites and minority groups (U.S. Bureau of the Census, 2000), and minorities could outnumber the total White population of elementary school children (Hodgkinson, 1992).

Since underrepresented groups in the scientific fields are few, including those majoring in the sciences, the next step becomes the understanding of the reasons why these groups are not entering these fields. Factors that contribute to minorities entering the sciences include schools that may not have proper staffing and, in minority communities (Clark, 1996), biases by teachers against cultural diversity, access to quality teachers and resources (NCTAF, 2003), access to resources, and curricula emphasis (NSF, 1996). In many colleges, multicultural programs for faculty and staff on student diversity are not successful because individual cultures are not taken into consideration. Instead, minority students are expected to adapt to the predominant White culture and faculty and staff are being held accountable for student change (Garcia, 1999; Helms, 2003). Cultural diversity is not embraced when faculty and staff look to change the student. However, cultural diversity is embraced when the faculty look at the students'

preferences and make modifications in their teaching to the student. Cultural differences should be viewed as an opportunity to improve learning and not as a challenge to make the student adapt to the dominant White culture.

Many minority students learn to dislike or fear the sciences. They graduate each level of schooling, including high school, with the minimal number of science courses. Many of these students, upon entering college, may be underprepared to enter the science fields. In addition, instructional and curricular methodologies must be considered when teaching students from different cultures. Educators of students in the K-12 school system, and in colleges must learn to understand their students' particular learning style by understanding their unique cultural background. Understanding that students from different cultures may have different learning styles is the first step to increasing student enrollment in science courses and interest in science careers.

Different cultures influence how students learn and acquire knowledge (Ogbu, 1992). Nisbett and Miyamoto (2005) and Stoughton (2005) discussed how students see a topic and process information differently depending on their background and culture. This is seen in how students behave in the classroom when presented with various activities (Anguiano & Harrison, 2002). Various studies have been done with students from various minority groups, from elementary schools through college, measuring elements of learning style as grouped into five categories: environmental, emotional, sociological, physiological and psychological (Dunn, Griggs, & Price, 1993; Yong & Ewing, 1992).

Tennant (2002) stated that "cognitive style, learning style, and conceptual style" (p. 80) are related terms which refer to an individual's characteristics and consistent

approaches to organizing and processing information. This concept is associated with research in cognitive styles, brain-based physiology, cultural study, and learning theories (Huitt, 2003; Jensen, 1998; Piaget, 1972; Vygotsky, 1978). In order to understand students, learning how they learn and how to adjust teaching accordingly is important.

Various learning style models provide foundational information for instruction and curriculum design. Various learning style models are used to design instruction. Examples of these models are the Myers-Briggs Type Indicator, Kolb's learning style model (1984), and Felder-Soloman Learning Style Inventory (Felder, 1996; Kolb, 1984; McCaulley, 1990). Because students learn in different ways, teaching methods should not only vary but also take into consideration these differences. While some instructors lecture and teach using a variety of activities, instruction may not consciously include understanding the student population they teach, particularly if that population is a minority group. If a mismatch occurs in teaching style and learning style, the student may not only do poorly, but may also withdraw from the class.

People of different cultural backgrounds have different ways they see themselves and others, including the way they see the interdependence of the two. For example, American culture is very independent and does not necessarily value overt connectedness among individuals (Markus & Kitayama, 1991). However, many minority groups, such as Hispanics, and African Americans, value interdependence. Knowing this information, instructional activities in classrooms can be geared to the culture of the minority groups who are being taught. Collaborative activities involving group interaction embrace the minority concepts of interdependence and construal of self and others.

South Florida has two colleges with high minority populations. Enrolled minority students at Miami Dade College include Hispanics (66.5%) and Blacks (20.8%), providing a total of 87.3% of the student population (Miami Dade College Fact Book, 2005). At Broward Community College, the percentages are 29.8% Hispanic and 28.5% Black, for a total of 58.3% (Broward Community College 2008 SAS Report). These colleges also have Haitian students and other minorities enrolled; however, statistics on these students are not available on an individual basis. Knowing the potential scientific shortage, and the underrepresentation of minorities in scientific careers, including the statistics showing that these groups do not succeed in these fields, this study is of utmost importance. Studying the preferred learning styles of the minority students and the implications for faculty teaching courses of knowing which styles might be better for the students' learning modalities, could result in better achievement in science for these students. In addition, better achievement in courses may lead to increased interest in careers in the sciences.

Limited research exists on learning styles in adult students. A few studies included comparisons of minority groups and their preferences in the health sciences and in accounting programs (Sauceda-Castillo, 2001; Tate 2003). Sauceda-Castillo studied accounting students and compared minority groups to their achievement in their college program. Little information exists, however, on how minority adult students learn or on how their learning style preferences affected their classroom performance, particularly in the sciences.

Problem Statement

A problem exists in understanding the relationship between learning styles of minority college students and their classroom performance (Anderson & Adams, 1992). Most studies conducted are on children in Grades K-12 and do not take into consideration the minority groups and preferences in learning styles. In addition, according to Banks (2006), cultural influences need to be understood. Evidence derived from the literature shows that students from different cultural backgrounds learn differently. In order to provide the best learning environment for students and employ learning methods that are amenable to their learning, the learning styles of students needed to be investigated. Students have different backgrounds, strengths and weaknesses, interests, ambitions, senses of responsibility, levels of motivation, and approaches to studying (Felder & Brent, 2005). College students from different cultures have different influences on their learning (de Vries, 2005). The understanding of how students learn impacts all students and their achievement. A gap in the literature pertaining to this particular group of adult learners exists, particularly when it comes to minority groups. Education strives not only to teach students subject areas, but also to build skills in both their preferred learning methods as well as the less preferred modes so that students learn to adapt to situations. Felder (2005) stated

> When mismatches exist between learning styles of most students in a class and the teaching style of the professor, the students may become bored and inattentive in class, do poorly on tests, get discouraged about the courses, the curriculum, and themselves, and in some cases change to other curricula or drop out of school. (para. 2)

Providing instructors with the necessary information about culture and its effects on student learning style preferences and achievement will enable professors to

incorporate more preferred learning style methods into their teaching. Though a combination of methods should be used (Felder, 1996), the incorporation of preferred styles in order to improve retention as well as achievement is important. This study will contribute to the knowledge foundations in the relationships between student achievement and learning style in minority college students.

This study can lead to various areas of future research, including understanding the cultures that students represent and how those cultures influence their learning, and which teaching/learning methods could be implemented to improve learning in different subject areas. It may not be the case that the same learning style is preferred in all subjects. This study could pave the way for innovative thinking in teaching minorities in the sciences in order to increase student achievement in this subject.

Nature of the Study

A quantitative study design tested the relationship between learning style preference and student achievement in minority students in biology classes at a South Florida college. The dependent variable was student achievement defined by the overall grade the student achieves at the end of the college term (16 weeks). The dependent variable, student achievement as measured by the overall grade is based on an A-F scale (A = 90-100; B = 80-89; C = 70-79; D = 60-69; F < 60). The independent variables were based on Felder's (1996), five main categories of learning styles, including correlating the preferred styles in the minority groups. The variables were statistically controlled in the study.

The nature of this study was to seek to understand the relationship between learning style preferences and achievement (grades) by the adult student in the various ethnicities representative in a multicultural college. The goal of this study was to correlate student achievement and the use of learning style techniques amongst various ethnicities at the college. The college has a high minority population of Hispanics, Blacks, and other minorities such as Haitians, and the achievement of these students are influenced by how they are taught. As a result of the study, recommendations for learning and teaching techniques for faculty use with these populations can be made. This is a new approach to the way faculty use teaching styles because by knowing the minority student population and understanding learning style preferences, adaptations in teaching techniques may improve student achievement.

Purpose Statement

The purpose of this study was to examine the relationship between learning style preferences and science achievement (grades) by adult minority students in a multicultural college. The specific populations under exploration were Hispanics, Blacks, and other minorities such as Haitians. Minorities traditionally do not enter science careers (Nelson & Rogers, 2006; NSF Indicators, 2006; USDA, 2005, 2006). Barriers exist both at the college level as well as from the home environment decreasing the minority enrollments in the sciences. The researcher was interested in obtaining data regarding learning styles and achievement so that recommendations could be provided regarding maximizing student achievement. Student achievement in the area of sciences may increase the number of underrepresented populations in a field that is dominated

primarily by Whites. In addition, the literature (Dunn, Griggs, & Dunn, 1993; Felder, 1988, 2005; Sauceda-Castillo, 2001) supported the premise that individual student learning style preferences are influenced by their own culture. Though students have individual learning styles, cultural influences may affect the way students may preferred to learn (Dunn, et al., 1993; Richardson, 1994). If certain learning styles may be preferred by minority students, and faculty employ teaching methods appropriate for learning styles that may be prevalent in a group, student achievement may improve. This could possibly lead to improved grades as well as achievement in science courses that may encourage minority students to enter into scientific careers.

Understanding any particular group of people is in itself difficult. Every culture has its own influences, including individual preferences. Each student must be assessed as an individual, however, knowing the culture and minority group from which the student comes from and the student's learning style can assist faculty in teaching students.

Research Questions and Hypotheses

The research in this study was designed to examine the relationship between learning style preferences and science achievement (grades) by adult minority students in a multicultural college. The research was based on correlating the learning style preference and achievement (grades) by the adult minority students. Questions that identified learning style preferences and student demographics were asked in the survey.

The questions that guided this study were:

1. Which learning styles are evidenced by college students as measured by the Felder-Solomon Learning Style Inventory?

2. What is the relationship of preferred learning style and achievement as measured by grade obtained?

3. What is the relationship between learning style and minority group defined by the college's demographic questionnaire?

4. What is the relationship between achievement and minority group defined by the college's demographic questionnaire?

The hypotheses that related to the research questions were:

Null Hypothesis 2: No relationship exists between preferred learning style and achievement as measured by grade obtained.

Alternative Hypothesis 2: A relationship exists between preferred learning style and achievement as measured by grade obtained.

Null Hypothesis 3: No relationship exists between a learning style and a minority group defined by the demographic questionnaire

Alternative Hypothesis 3: A relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Null Hypothesis 4: No relationship exists between achievement and minority group defined by the college's demographic questionnaire

Alternative Hypothesis 4: A relationship exists between achievement and minority group defined by the college's demographic questionnaire

Theoretical Framework

The two main areas in psychology from which the hypotheses are generated are constructivism and social cognition. Constructivist theory builds knowledge based on previously gained information and or experiences (Vygotsky, 1978). Social cognitive theory, based on Piaget's (1972) theory of cognitive development, includes the premise that social interaction is fundamental to the development of cognition. Cognitive learning theories are based on how learners process information. Learning takes place when connections are made between the neurons in the brain, connection in their mind, and between knowledge already in place. For teachers to succeed, they should be aware of the connections between cognition, the student experiences, knowledge skills and lives (Caine & Caine, 1994). The brain's physiology and function are closely related to cognitive theory (Gardner, 1993).

Various proponents of learning theory indicate the critical importance of culture and social context for cognitive development and the association with constructivist theory (Huitt, 2003; Vygotsky, 1978). In addition, Huitt (2003) discussed how knowledge is based on previously gained information and or experiences. Jensen (1998), using brain-based learning as a learning theory, stated that the brain is social, complex learning is enhanced by challenge, learning is developmental, and meaning is important. These theories support the premise that social interaction and culture are important in cognitive development and that the brain is social also being influenced by culture. These learning theories are the basis for the learning style theories.

Learning styles are a collection of various modalities that determine how an individual perceives, processes and understands information (Claxton & Murrel, 1987).

Students exhibit different approaches to learning (Felder, 1998; Richardson, 1994). Learning styles are ways in which students use information and stimuli to gain cognitive knowledge (Felder, 1993; Vygotsky, 1978). Various learning style categories or modalities exist defining the different learning methods. These are discussed in chapter two of this study. The method that this study employed to ascertain the learning style of students uses the Felder-Silverman learning style dimensions (1993). Felder and Silverman (1988) proposed learning style dimensions based on psychological theories (Jung, 1971) and learning theory (Kolb, 1984). The Felder and Silverman (1988) learning style dimensions have various categories incorporating the perception, processing, comprehension and understanding of information. These dimensions were used by Felder and Soloman (1999) for the Learning Style Inventory, a survey tool that assesses learning style. The survey tool was comprehensive and provides the five dimensions of learning styles.

Definition of Terms

The following section provides definitions for terminology used in this study so that the reader has the same meaning as the author. Various definitions and interpretations exist for the terms used but these definitions are appropriate for the terms in this text.

Ethnicity is defined by Banks (2006) as "people who share a common ancestry, culture, history, tradition, and sense of peoplehood" (p. 79). In general, members of an ethnic group have distinguishing cultural characteristics that unite them, such as religion,

values, food preferences, and physical characteristics that allow people to identify each other more readily than others (Banks, 2003).

Minority groups are defined by Schermerhorn (1970) as a group based on relative size and power. This definition also entails race, ethnicity, religion, language, and other characteristics typically associated with minority groups. Oftentimes, the term minority also is related to a subordinate position with regard to power, status and economic opportunities. Though minorities in various regions may comprise the majority population, they are linked to low socioeconomic status and power.

Races are categorized by the U.S. Census (2000) are White, Asian American, Black or African American, and Native Hawaiian and other Pacific Islander. The category of "some other race" was defined as anyone who cannot identify with the five listed categories.

Culture relates to sharing a common view of values, behaviors, characteristics, experiences, social aspects, and language that are different from other ethnic groups (Banks & Gay, 1978). Pederson (1994) defined culture as a shared pattern of behavior, which is transmitted to others in a group. Culture can also be defined as the "shared models people carry in their minds for perceiving, relating to, and interpreting the world around them" (Spindler, 1984, pp. 4-5). Culture in this study is that of a shared common view of values, behaviors, characteristics and social aspects that are used in perceiving and interpreting the environment and what is being learned. This explanation of culture, encompasses the varied definitions, and explains what is meant in this study.

Multicultural education is defined by Banks (2006) as "a combined thought or process involving people of color, women and other groups" (p. 78). This type of

education has many broad implications and incorporates cultural influences. This concept should be used as a focal point for discussion of a variety of minority groups within a population. This is how this concept is used in this study.

Learning styles are defined by Grasha (1996), as "personal qualities that influence a student's ability to acquire information, to interact with peers and the teacher, and otherwise to participate in learning experiences" (p. 41). Felder (1996) defines learning styles as characteristic strengths and preferences in the manner in which students take in and process information. James and Gardner (1995) define it as the manner in which people process, store and recall what they are attempting to learn. In all definitions, learning styles entail the student's ability to relate new information along with the environmental factors which allow a student to acquire new knowledge.

Achievement is defined using the South Florida college's level of passing grades in science classes, which is a grade of C or better.

Assumptions

The research project may have unforeseen circumstances that could have affected it. The researcher made certain assumptions:

1. A sufficient numbers of classes would be scheduled in the Biology Department at the college providing the appropriate sample size.

2. The sample in the study would be representative of the minority student population at the college.

3. The students in the randomly selected classrooms would complete the surveys honestly and answer the questions in a serious manner.

4. Students enrolled would attend class when the surveys are administered, thereby insuring the appropriate sample size.

5. Each student would have a computer available to take the LSI Inventory online.

6. The survey would remain attached to the demographic data thus providing student personal demographics and learning style relationships.

7. The instructors of each course would provide the researcher with the student grades at the end of the semester.

8. Unforeseen climatic events would not occur that could adversely affect the study.

9. Random selection of classes would provide a variety of times, both day and evening classes as sample courses.

Scope, Delimitations, and Limitations

The scope of the study is based on the minority groups in the college where the research was conducted as well as the student sample being representative of the population at the college.

A delimitation of the study was based on the learning style preferences of students studying in science and specifically, biological courses. Since many natural science subdivisions (biology, chemistry, earth science, physics, astronomy, geology, and space science) exist, the study was limited to only biology classes. The reason for choosing biology classes for the sample was that this is the researcher's expertise and is an area where minorities are underrepresented. The delimitation of only biology classes also decreased variables which pertain to other science courses. The study was administered

to all students in the classes selected, however, the focus was restricted to the minority groups in the study: Hispanics, Blacks, and Haitians, and others including Whites which may be included as part of the survey process. The sample was representative of the South Florida college population in which the study was conducted and was not meant to have inference among other minority groups and in other locations. In particular, the Hispanic population in South Florida is different from the Hispanic population in other parts of the United States and other areas. For example, Hispanics in Florida are mostly comprised of Cubans, Puerto Ricans, and Central and South Americans, whereas, the Hispanic population in Texas is mostly that of Mexican origin (National Council of LaRaza [NCLR], 2006). The study was also restricted to adult college students and did not take into account where previous schooling took place. This inference regarded where the student graduated from high school or obtained an alternate high school diploma, or GED.

Limitations of the study regarded the applicability of results to other science courses in biology and in other science fields. The study was also not ascertaining differences, if any, by full-time and part-time students. A limitation of this study was the researcher's connection to the college and accessibility to the science departments. Another limitation was that random selection of the classes for the study may not provide a wide distribution of day and evening class.

Significance of the Study

The significance of this study was that the results could be used to make recommendations to improve achievement of the adult minority student in biology

courses. Using the data provided, faculty could use this information to teach minority groups in their class and increase learning achievement. Faculty professional development workshops and summer institutes could be planned to teach faculty on the learning style preferences in the students at the college.

The recommendations made from this study are revolutionizing for college instructors since knowing how students' best learn, faculty can incorporate teaching strategies to the minority group being taught. This is a unique area in adult education. The literature has published very little in this area for the adult minority groups. This can open a new era in educational research. For example, Kreuze and Payne (1989) did a study concluding that there was no particular teaching method specifically appropriate for Hispanics. However, research in the field lacks studies correlating achievement to learning styles. The proposed recommendations can lead instructors to implement more appropriate learning/teaching techniques for students. Due to the aforementioned, future decrease in the scientific community and the usually low number of minorities that enter scientific careers, this study can significantly begin the process of changing how educators teach minority students, how they achieve in the sciences, how they perceive science courses, and the careers they ultimately choose. In addition, the intention is that this research incites additional research in other science courses and nonscience courses, to address learning styles preferred by minority groups as well as by all students.

An educationally responsive community should ascertain the student's preferred learning style so that increased student achievement can be obtained. In addition to faculty learning how to teach minorities, advisors, can help students match their learning style to faculty teaching styles. This study provided a basis for faculty to form

teaching/learning communities and provide information to students about teaching and learning style preferences. Using research-based data this can lead to educational reform through learning communities allowing faculty to reflect on their teaching and student learning (McLaughlin & Talbert, 2001).

This research can be used as a basis for a high school study or middle school study in the sciences to relate learning style preferences and if achievement can be obtained at a younger age in minority groups. If educators can hook students early in the sciences, perhaps more will choose scientific careers.

Implications for Social Change

Few minorities enter scientific careers. A tremendous implication refers to how these typically low socioeconomic groups can be helped to better achieve in an area where they are underrepresented both in education, and in the workforce. With the retirement of almost 50% of scientists and the predicted rise of the minority population, the economics as well as the workforce population demographics can significantly change. In addition, the way education looks at students, in particular, the adult student, will need to be addressed in future studies by educational leaders supporting faculty learning communities, professional development, and reform in teaching methods applications. As educators learn about student learning styles, and in particular, those of minorities in different regions and populations, adaptations in teaching and improvement in achievement will be obtained. Banks (2006) stated “A major goal of multicultural education, as stated by specialists in the field, is to reform schools, colleges, and

universities so that students from diverse racial, ethnic, and social-class groups will experience educational equality" (p. 3).

Summary

Educational achievement, especially in the sciences of ethnic minority students is far below the norm in the United States. Minority students can have lucrative careers in the sciences if they are assisted in succeeding. If minorities succeed in science courses and if learning style preferences can be ascertained by faculty, increased interest in science careers by these students can open career choices. Future shortfall in the sciences and in particular, scientific careers in research can be met by assisting minorities in their achievement in science courses and degree programs. This can be done by ascertaining what factors can best assist student achievement in the school system and in particular in higher education. This study serves as a foundation for changes that can significantly affect student achievement in minorities, how faculty teach, and the impact this can have in the scientific community.

Chapter 1 introduced the background and theoretical framework for this study on the relationship between student achievement and learning style preference in the adult minority student. The statement of the problem, purpose, definition of terms, scope, delimitations, limitations and significance of the study were discussed. Implications for social change and educational transformation are an integral aspect of the study and its results leading to significant additional research and transformation in how faculty teach minority students in college. Chapter 2 elaborates on the theoretical framework with

respect to learning theory and relationship to learning styles, which were the framework for this study.

CHAPTER 2:

LITERATURE REVIEW

Introduction

Chapter 2 presents the literature and information pertaining to academic and learning achievement. The literature is divided into four categories: (a) learning theory, (b) learning styles and the Learning Style instrument, (c) cultural effects, and (d) barriers to minority student achievement. Knowing how to teach is almost an obvious expectation; however, literature demonstrates that teachers need to spend considerable time learning how to teach and that students learn differently (Dembo, 2001; Singer, 2003).

Learning theory is the basis for understanding how students learn. A review of the literature on learning theories highlights two main areas from which the hypotheses are based: constructivism and social cognition. Constructivist theory builds knowledge based on previously gained information and experiences (Vygotsky, 1978). Social cognitive theory, based on Piaget's (1972) theory of cognitive development, includes the premise that social interaction is fundamental to the development of cognition.

Vygotsky (1978) emphasized the critical importance of culture and social context for cognitive development. Using constructivist theory, Huitt (2003) discussed how knowledge is based on previously gained information and or experiences. Constructivism and social cognitive theories are chosen because they support the premise that social interaction and culture are important in cognitive development and that the brain is social, also being influenced by culture.

In applying learning theories to teaching techniques, cultural diversity should be considered when planning learner-centered activities and projects (Early, 1994). In order to assist students to succeed in the class, a variety of projects as well as styles (self-directed, self-centered, and collaborative) can be employed to accommodate student learning and cultural styles. (McLaughlin & McLeod, 1996). Learning styles will be discussed in a later section in this chapter.

Learning Theory

This section discusses the learning theories which are the basis for the hypotheses in the study and the learning styles which resulted from understanding how students learn. The literature shows that research on the brain, its physiology and functional development are closely related to cognitive theory (Gardner, 1993; Gazzaniga, 1985). Processing information is part of brain function. The biology of the brain and the relation to function and knowledge are closely related. Tanner and Allen (2004) stated

> From a biological perspective, the brain is the organ of learning, and as such, a learning style is likely to be a complex, emergent interaction of the neurophysiology or an individual's brain and the unique developmental process that has shaped it through experience and interaction with the environment. (p. 198)

A review of the literature reveals two basic schools of thought: (a) that learning can be studied independently of the environment and that it takes place within the individual (Bruner, 1990), and (b) that learning has a connection to the environment and thinking is a result of these interactions (Greeno, 1989). The individual has innate abilities that allow development of thinking and knowledge based on the interactions with the environment. Huit (2003) developed an ecological model for development of

cognition that is focused on the interaction of the individual with the environment. As complex systems are studied, the individual's perceptions are also interlaced with their background and culture, which can be their environment as well (Bush 2003).

Dewey was a leader in the progressive education movement early in the 20th century. Dewey (1944) proposed that "ones' reflection on personal experiences would provide the foundation for the development of the necessary attributes for successful living" (as cited in Lutz & Huitt, 2004, p. 68). Constructivist approaches to learning have their basis on the studies and research done by Dewey (1998). A main aspect of his theories is based on an individual value of personal experiences in learning and that environmental factors were important in learning. Through his understanding of how individuals learn, Dewey paved the way for others who expanded on his theories.

Cognitive learning theories are based on how learners process information. Learning takes place when connections are made between the neurons in the brain, connection in their mind, and between knowledge already in place. For teachers to succeed, they should be aware of the connections between cognition, the student experiences, knowledge skills and lives (Caine & Caine, 1994).

Piaget (2001) was a behavioral scientist who developed one of the most important theories in cognitive psychology. The impact of his theory of cognitive development had a major influence in the field of psychology. He intertwined the role of biology on development of knowledge. In Piaget's theory, mental adaptation was a result of how an individual interacted with the environment to gain knowledge. His theory can be understood as having two main aspects of development: (a) adaptation, and (b) cognitive developmental stages. Biology is adaptive and influenced by environmental factors.

The adaptive process can be accomplished in two different ways: assimilation and accommodation. These two processes are critical to understanding constructivism. Adaptation is due to an individual's ability to continue to build knowledge continuously through interactions with the environment, and through self-construction. These interactions allow an individual to build cognition. Discrepancies between the mental constructs and the environment in an individual provide the choice to assimilate or accommodate to the situation. Assimilation entails changing the way the environment is viewed with the information at hand. Accommodation on the other hand, is the changing of the cognitive structures. Either way, adaptation occurs by the learner. The resulting knowledge is that of an interaction of adapting to the environment and to cognition.

Cognitive development according to Piaget (2001) developed in sequential stages. In all stages of development, three types of knowledge must be present: physical, logical-mathematical and social (Driscoll, 2001). These lead to understanding of learning and learning styles. Physical knowledge is learned and obtained through hands-on activities. Logical-mathematical knowledge is obtained through actions of repeated exposure and multiple interactions. Lastly, social knowledge is obtained through interaction with other social beings. The latter has connections to culture and to environmental factors pertaining to them. All three cognitive developmental stages are used by the individual's interaction with the environment. Piagetian theory has had a great influence on learning theory and henceforth on the understanding of learning styles.

Vygotsky (1978) emphasized the critical importance of culture and social context for cognitive development. Social interaction is the basis for all learning and development in his theory. Wink and Putney (2002) discuss the main principles

underlying his theory. They are social interaction, limitations dependent on time span, and that learning needs to be studied in an environment where learning takes place. The latter impacting where research on learning should be taking place.

Mental functions exist in two levels, that of elementary and higher mental functions. People are born with elementary functions while higher mental functions are results of interactions with other individuals and society. Vygotsky (1978) saw this as a function of how higher mental functions are created through culture and the use of the particular cultural tools, language and symbols. Using cultural constructs, individuals learn what is valuable as knowledge to be remembered, honored, cultivated, and its process. An individual's society or culture, therefore, is the primary force for dictating what is important to learn and for an individual's cognitive development.

Vygotsky's belief (1978) that studying the process of learning in the environment where learning is taking place, rather than the product, embraces Piaget's theory that the learning is adaptive and can be either assimilated or accommodated. The process of learning, rather then the product is the emphasis. In essence, the process of learning is an adaptation due to the environmental factors that are present and ever changing. In addition, the learner is actively involved in modifying the learning environment as a part of learning.

Using constructivist theory, Huitt (2003) discussed how knowledge is based on previously gained information and or experiences. Supporting this, Barley et al. (2002) explained constructivism as an active process. The active participation of the individual information is used to construct and process the learning. Supporting this, brain-based learning research (Jensen, 1998) shows that the brain is has a social component and that

complex learning is enhanced by challenge, that learning is developmental, and that meaning is important.

Bruner (1990), using constructivism, embodied the various theories including Piagetian belief that cognition occurs in stages that are based on previous knowledge gained. Learning takes place through the connections of previously learned information and linking it to the learning taking place. Whereas Piaget maintained that learning has to take place at the right stage of childhood development, Bruner's belief is that it can take place at any time, however, during life's experiences, additional knowledge and experience is gained supplementing this knowledge.

Bruner also incorporated Vygotsky's theory relating to how culture influences cognition. Culture (Bruner, 1987) is a guiding factor in how learners see and adjust to new learning environments. If different cultures have different symbols and tools of learning, then students or learners will see the environment based on their previous experience in their culture. Piaget's view was different in that his theory was based on believing that all children passed through the exact same stages regardless of their cultural background. Driscoll (2001) discussed how culture and how the individual's society affects how an individual views the environment and that based on this, the learning that takes place is fashioned by the individual's cultural views.

Huitt (2003) discussed how an individual's cognition is a result of various components involving the mind, biological maturation, and the environment. Environmental influences include family, local neighborhood or community, and culture. (Bridge, Judd & Moock, 1979). Given all the previously discussed theoreticians and their views on learning theory, Gardner (1983) presented a perspective on learning theory

based on eight different levels of intelligence: linguistic-verbal, mathematical-logical, visual-spatial, bodily-kinesthetic, musical-rhythmic, interpersonal, intrapersonal, and naturalistic. These relate to a preferred method of learning by an individual. Each individual in turn has a preferred method, which is related to culture. If the perspective on learning theory and intelligence is implemented, learning situations can be tuned in to individuals within a culture. In other words, learning styles are based on individuals in a culture and learning can be influenced by knowing the individual's preferred learning style. Knowing that learners may have a preferred learning style can help achieve optimal learning environments and situations.

Learning Styles

The understanding of learning styles in adult education and specifically with minority students is needed since these groups have less academic achievement than White students. Understanding how students learn, the learning style characteristics and preferences can aid teaching practices (Felder, 1998). Learning styles are a collection of multiple modes that determine how an individual perceives, processes and understands information. Learning styles are the modalities by which students most efficiently learn (Claxton & Murrell, 1987). They also are a major factor influencing a student's educational performance (Claxton & Murrell, 1987; Dunn & Dunn, 1979; Felder, 1998; Torres & Cano, 1994). Students exhibit different approaches to learning and that this may differ from culture to culture due to its influences (Richardson, 1994).

Multiple intelligence theory (Gardner, 1993) states at least seven different ways of looking at information and learning and that skills can be developed in each of these

intelligences that allows learning to take place. Various learning style models have been devised that enable evaluation of student learning styles (Fox and Ronkowski, 1997). Instruction should be adapted to the learning style of the student (Felder, 1988). This is an interesting facet of pedagogical adaptation. Depending on the demographics of students, instructors may find themselves with a wide variety of cultural representations or they may find themselves teaching a vast minority population. Bush (2003) identifies cultural factors that might explain differences in mathematics achievement and attitudes. Banks (2006) discussed how cultural influences need to be understood in order to assist students. Since the cultural aspects influence learning, the instructional pedagogy should be adapted to accommodate the learner (Felder, 1988).

Learning styles are ways in which students use information, stimuli and other forms of processes in a consistent manner to gain knowledge (Felder, 1993; Piaget, 1950; Vygotsky, 1978). Learning styles are not isolated categories but are a scale by which a preference may be made in the way a person learns. People can learn in multiple ways, however, the preference for learning may differ.

A learning style can be defined in various ways, including the preference by which individuals learn best. A learning style does not preclude that individuals can learn in multiple ways and using various tools, rather it indicates that a preferred learning method exists by which information is attained, reflected upon and understood. In addition, as theory indicates, Tanner and Allen (2004) stated

> From a biological perspective, the brain is the organ of learning, and as such, a learning style is likely to be a complex, emergent interaction of the neurophysiology or an individual's brain and the unique developmental process that has shaped it through experience and interaction with the environment. (p. 198)

One of the oldest and simplest methods to look at learning styles involves three categories: (VAK) visual, auditory and kinesthetic (Tanner & Allen, 2004). Learners use all styles to learn, however, they exhibit a preference or a dominant style. The latter is the style the student prefers and is the best way the individual learns. The dominant style is reinforced or supplemented by the others. VAK refers to sensory modes of learning. An additional area was added by Fleming (1998) in a learning style inventory (VARK) to include reading-writing. These rely on the individual learning style preferences using sensory domains.

Instead of ascertaining learning style preferences based on sensory modes, Gardner's use of Multiple Intelligence Theory (1983), included additional modalities of gaining knowledge through intelligence. He added to the four-aforementioned modes; linguistic-verbal, logical-mathematical, visual-spatial, bodily-kinesthetic, musical-rhythmic, interpersonal, intrapersonal, and naturalistic. The way each individual uses the various intelligences determines the learning style (Gardner, 1983, Pues, 1994). Within these one can find the sensory modalities of learning that are inclusive in these intelligences.

VARK and Gardner's theory of Multiple Intelligences pre-set the ideology of learning styles and how students can best learn in the classroom. The literature research reveals numerous studies which have been conducted on the adult learner (Baumgartner, 2001; Merriam & Caffarella, 1991). Adults learn best when they can decide when where and how to learn (Merriam & Caffarella).

Additional review of learning style literature includes Kolb's description of learning as a process that interconnects experiences with concepts (1984). Kolb drew the

learning style modeling theories from Dewey and Piaget (Kolb, 1984). Using experiential modeling from these theories, he described two main processes or dimensions in learning: apprehension and transformation. The apprehension dimension includes opposing ways to view experience, concretely and symbolically. The transformation dimension entails intentional reflection and that of action. The four modes of learning for Kolb are: concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). Individual learning styles are a combination of two modes of learning. Based on these, four basic learning style preferences arise: convergent, divergent, assimilation, and accommodation. These are combinations of the dimensions of learning (Kolb, 1984).

In Kolb's definition, and in others, the environment has an impact on the learner. The environment affects how the learner perceives and processes information. Kolb (1984) hypothesized various subject majors to be associated with these various categories and that learning style preferences differed according to undergraduate major. In his analysis, he found that business majors are accommodators, social science majors, are divergers, engineers are convergers and science and mathematics majors are assimilators. These are tendencies and are not to be taken as exclusively being so.

Science education has limited researched information on the adult minority learner and in particular those in science classes. Felder and Silverman realized that there was a disconnect between learning in science classrooms and with teaching styles traditionally acceptable in these classes (Felder & Silverman, 1993). The research conducted has direct implications to science education. Tobias (1990) realized that how students learn in science classes is different from how learning takes place in other

subject areas. Inspired by this information, Felder and Silverman began their research into science and in particular, adult learning in engineering classes.

Felder and Silverman (1988) found that student learning is based on both a student's ability and previous academic preparation, and the compatibility between the learning style and instructor teacher style. Mismatches can occur between a student's learning style and a teacher's teaching style. This in turn may lead students to a negative attitude about class, a subject matter through boredom, inattentiveness, and ultimately failure (Felder & Silverman, 1988; Tobias, 1990).

The learning style dimensions proposed by Felder and Silverman (1988) were based on some previously ascertained models and new concepts to provide teachers with teaching styles that may be better suited to teach the students once their learning styles are known. Their concept was that if student learning styles are known, teachers can incorporate teaching styles that would address the student learning styles and mismatches between these would be minimized. They also realized that teachers cannot incorporate all teaching styles to suit all learning styles, however, through minor modifications of teaching methodology, the learning styles can be addressed at various levels (Felder & Silverman, 1988; Felder & Spurlin, 2005; Livesay, Dee, Nauman, & Hites, 2002; Zwyno, 2002).

Felder and Silverman (1988) stated

> the proposed learning style dimensions are neither original nor comprehensive. For example, the first dimension, sensing-intuition is one of four dimensions of a well-known model based on Jung's theory of psychological types, and the fourth dimension, active-reflective processing is a component of a learning style model developed by Kolb. (p. 675)

The dimensions proposed, as can be seen from the Kolb (1984) model, have areas that incorporate various previously described learning models. One very different aspect in the Felder-Silverman dimensions from other learning style models is that they separate learning into phases: (a) perception (how students perceive information), (b) reception (how is the information is received, whether visual, auditory, or kinesthetic), (c) organization (how the information is organized), (d) processing (how the information is processed), and (e) understanding (how understanding takes place). The underlying theories for the Felder-Silverman learning style dimensions borrow from psychological theories (Jung, 1971) and learning models from Kolb (1984). Though Jung's theory contributed to the first area of how students perceive information and Kolb's theory contributed to how students process information, the Felder-Silverman dimensions are a unique method for understanding learning styles for it takes learning to a new dimension. There is little to explicate regarding the incorporation of Jung's theory other than that students perceive information using senses and or their intuition. Learning styles are incorporated into the phases of how information is perceived, processed, comprehended and finally learned through understanding. No other learning style dimensions bring this into perspective. The dimensions of learning incorporate how the brain processes information and how the senses are linked to input of the information.

The Felder-Silverman model shows that students can differ in how they learn. The original model emphasized four different but dichotomous methods of learning: sensing-intuitive, visual-verbal, active-reflective, and sequential-global signifying the individual's preferred learning style. What these method refer to are (a) the sensory method by which information is received, (b) the modality by which information is

received, (c) the process why which information is received, and (d) the order in which the information is received. Each student learns using the four areas or dimensions by which the information is learned. The emphasis of these areas of learning is that they are a continuum and are related to each other. In addition, the individual methods are indicators for not only how students learn, but how teaching can be accommodated to the stream of learning continuum.

In order to further understand the five main categories, an explanation of the areas is required. Of relevance is the need to understand that these extremes represent the continuum by which students can learn and understand.

Students under the Felder model are classified into five main categories:

1. sensing learners (concrete, practical) or intuitive learners (innovative, conceptual),

2. visual learners (pictures, diagrams preferred) or verbal learners (written and spoken information preferred),

3. inductive learners (prefer understanding from specific to general terms) or deductive learners (prefer understanding from general to specific),

4. active learners (prefer to do things) or reflective learners (prefer to think things through), and

5. sequential learners (prefer to be orderly, linear) or global learners (holistic, system thinkers).

Understanding these categories are relevant to teaching pedagogy for these are what teachers can use as teaching techniques to increase student learning. Instructional methods and the use of pedagogy conducive to the learner can affect student learning and

particularly in science. Felder and Silverman's research (1993) indicates that the categories or dimensions of learning style can be used to further enhance student learning in science. The next section discusses these dimensions and how they relate to learning.

In the model, sensory students receive factual information and memorize well, whereas students who are intuitive perceive concepts and understand ideas better. Whereas, the sensory learner is adept at details and facts; the intuitive learner is skillful at instinctual and innovative approaches and ideas.

The next area in Felder's five classifications is that of visual and verbal learning. This is how the learning can take place; the actual sensory method. Visual learners learn better when they see objects, pictures, diagrams, whereas, verbal learners learn best when they have auditory input. In addition, verbal learners also learn best through talking, writing, and discussion.

Inductive and deductive learning relates to how a problem is ascertained and approached by the student. Inductive learners can address a problem as converging on a whole from the small intersections to the complete picture. They see specifics and move towards concepts and principles. Inductive learners prefer going from specific information to understanding the general picture. Deductive learners instead see the whole and move to the parts. They begin with generalities and with principles and move towards the individual applications. The deductive learner prefers seeing the general picture or concept dissecting it to the small or specific parts.

The fourth classification of active versus reflective learning continues to offer a continuum of learning by individual students. Active learners prefer to be doing and being hands-on with activities. These may include discussions, active participation in

group work and other dynamic modes of learning. Reflective learners, on the other hand prefer to do individual work, time to understand information, and to be doing so mostly in isolation away from other people's opinions.

The last classification relates to the preferred method of obtaining and building information, sequential versus. global learning entails methodology in learning. Sequential learners prefer to learn linearly; in an organized manner and step-by- step fashion. They may learn from the small to the larger picture in a sequential step-like fashion. On the other hand global learners see the whole picture and concepts and proceed to then detail the whole to its parts.

The Felder Silverman model of dimensions of learning styles is a compilation of five different arenas contributing to learning. They assess the information and their perception (sensory-intuitive), the modality or perception (visual-verbal), the way the information is organized (inductive-deductive), the way the information is processed (actively or reflectively), and the way the information is understood (sequentially-globally). In all dimensions, the learning styles are a dichotomy of learning and are continuous without extremes necessarily, but a stream from one end to the other. "The preferences on a given scale may be strong, moderate, or almost nonexistent, may change with time, and may vary from one subject or learning environment to another (Felder, 1993, p. 286). The range in the scale for each of the modalities in the learning styles varies and is not finite. This gives individual students a variety of ranges in between the two extreme continuums of preferences. There are five phases and aspects for learning in the learning style models, providing for 32 (2^5) learning styles in the Felder-Silverman model (1984).

Various methodologies are available that can determine learning styles. Felder (1996) studied engineering students whose retention rates were low and devised a learning style inventory (LSI) with Soloman (1999) that detailed the five dimensions of learning styles. The Learning Style instrument will be described and discussed in chapter three.

Tobias (1990) defines two types, or tiers of entering college students; those who enter as science majors and graduate as such, and those who entered with the intention but changed to nonscientific fields. In her study, Tobias determined that the number of students who changed majors to nonscientific fields might in fact, be enough to prevent the shortfall of American scientists and engineers that has been widely forecast for the coming decade.

Some students prefer certain methods of learning (Diaz & Cartnal, 1999). Knowing the learning styles of students can assist them in higher achievement. (Hodges, 1988). Educational strategies used to improve adult student learning can be used to provide ideas and considerations for forming educational practices (Wang, Haertel, and Walberg, 1997). Chapters one and two discussed the low minority achievement in K-12 in science and the factors that permeate this. Minorities are underrepresented in science and math beginning from elementary to graduate school. Access to good schools with resources and teachers qualified in science and mathematics is a common problem that minority students encounter (Oakes, Ormseth, Bell & Camp, 1990). This decreases opportunities for minority group achievement in these areas. Due to low achievement in science classes, minorities become embedded in a sense of failure in this subject area, therefore, they choose careers other than science. Felder (1993, 1996, 2005; Felder &

Silverman, 1998) has found that students in engineering classes, like other sciences, perform better when learning styles are taken into consideration by instructors.

A science biology course can be organized to incorporate the learning activities which would relate to the students' learning preferences. Though each student has individual student learning preferences, a class with a high percentage of minority students from a particular culture, can benefit from instructional methods and applications conducive to that minority group. Studies show that student achievement and motivation, improve when teachers instruct using methods that match student learning style preferences (Dunn, Griggs, Olson, Gorman, & Beasley, 1995; Wakefield, 1993). Shifting instructional methods do not need to be major ones (Felder, 1993). Providing the learning environment which enhances student learning may include a variety of methods pertaining to the five dimensions of learning. Instructors who understand who their students are; including their culture, minority group, and learning style preferences, can implement strategies that cater to the student needs. Murphy, Gray, Straja and Bogert (2004) studied learning style preference in dental students. The study revealed that these students in general preferred visual learning methods. Students preferred and chose teachers who used visual teaching methods and facilitated note-taking during lectures. Students who understand what their learning style preferences may learn more than those who do not know (Lang, 1999). Teachers and their roles include not only being an expert in the field but also include being a guide who is responsible for facilitating the learning of the content being taught. Student achievement improves when teachers instruct using methods that take into consideration student learning style preferences, including cultural

influences (Anguiano & Harrison, 2002; Dunn, et al.,1995). The next section in this chapter discusses culture and the various aspects of cultural biases.

Culture and Cultural Biases

In reviewing the literature, a focus was on cultural influence and how it may influence learning. Minority groups have varying environmental and cultural differences that impact learning. Breen and Kessler (1994) indicate that educational processes need to understand and include cultural influences. The study conducted indicated how different cultural backgrounds can influence the student learning. In addition, Dunn and Griggs (1996) discussed Hispanic-Americans and how customs, language, religious beliefs and strong sense of family commitment affect the student's perception in the classroom. Different cultures influence how students learn and acquire knowledge (Ogbu, 1992). Nisbett and Miyamoto (2005) and Stoughton (2005) discussed how students see a topic and process information differently from different perspectives given their background and culture. Students behave differently in the classroom when presented with various activities (Anguiano & Harrison, 2002).

The population of the United States is diverse with growing minority groups. According to In the Bureau of the Census Current Population Survey Report (1999-2001), the projections show that minorities (Asians-Pacific Islanders, Blacks, Hispanics, and American Indians-Alaskan Natives) are expected to be more than half (52%) of the resident college-age (18–24 years old) population of the United States by 2050, up from 34% in 1999. Cultural influences in these populations have a role in how students learn. Tate (2003) stated that "Culture is passed from generation to generation and consists of

shared beliefs, knowledge, and behaviors of various members of a group" (p. 27). Cultural influences are categorized into basic and economic areas including poor, middle class, nationality, religious beliefs, race and food. The various characteristics involved in cultures influence an individuals' viewpoint. Breen and Kessler (1994) indicated the importance of understanding the connection between race, social class, and culture in planning instruction.

Cultural biases from the majority dominant White culture have passed on discriminatory viewpoints that may be unfair to minority groups. (Cross, Bazron, Dennis, & Isaacs, 1989; Lindsey & Roberts, 2005). Cultural awareness can diminish fear of the differences that cultures may portray. Cultural differences may provoke disapproval, fear and resentment by those who do not understand the differences. In addition, lack of knowledge or experience in multicultural settings may render an individual to have biases including sentiments such as fear, anger and resentment. Culture is a defining aspect of every individual and of the collective group. Every person lives and is representative of that culture (Nuri Robins, Lindsey, Lindsey, & Terrell, 2002). The subsequent section of this chapter addresses the barriers associated with minority student achievement, particularly in the sciences.

Instructors in college do not know offhand, unless they are teaching at a predominantly minority group higher education institution, who their students will be. In a multicultural institution, an array of cultures and minority groups may populate the classroom. Instructors cannot know everything about each cultural group they may encounter, and therefore, insufficient information or knowledge could lead to biases. Such biases are usually due to distorted generalizations about students because their

cultures are different from those of the dominant culture, and may lead to assumptions about students being deficient (Garcia, 1999). Cultural proficiency is an important aspect in the process of teaching minorities; however, it is not the only barrier that students may encounter. Cultural barriers to minority achievement are discussed in the next section.

Barriers to Minority Student Achievement

A variety of situations and circumstances affect the achievement of all students in education, and particularly minorities. Helms (2003) stated that "assumptions about who people are and are not create limitations that allow ethnocentric and racist ideas to flourish and permeate" (p. 27). Differences in educational opportunities for different cultures and minority groups may provide information on how to remedy the differences. Differences in achievement and participation in subject/programs may be perpetuated by teachers, economics, and biases. Oakes (1990) stated "Disproportionately more African-American and Hispanic minority students, poor students, and inner-city school students are classified by schools as being low in academic ability and not likely to attend college" (p.14). Oakes also discussed how social, political, and economic conditions amongst these minority groups can explain why these groups are low-income, and why they are perceived to have the potential to achieve less than those in the White majority. The same parameters affect the White cultures, but in an opposite way; they are economically better off and are considered to be able to have a higher chance of achievement.

The main barriers to minority achievement as related to this study can be categorized into five main areas: (a) judgments about ability, (b) access to science and math programs, (c) access to qualified teachers in science and math, (d) access to

resources, and (e) opportunities in the classroom. Each area presents its own insight as to how these barriers minimize participation by minority groups in science and math courses, programs and careers.

Judgments About Ability

Low income minority students may enter schools as early as kindergarten with initial learning difficulties (Slavin, 1987), which may lead to an initial labeling of low-ability, and therefore, placement in a low-achievement class, slow track, or remedial classes. Some of these students may be placed in special education programs from an early onset. Lack of cultural understanding by the teachers and school administrators may lead to stereotyping of minority students (Gomez, 1999). White upper socio-economic students are more likely to be identified as more apt and able to learn and placed in enriched programs (Darling-Hammond, 1985, 1987).

By the time many minority students reach high school, most of these students enter vocational programs whereas; White students enter college prep academic programs that prepare them for college (Rock, Braun & Rosenbaum, 1985; NSB, 2006). Educators teaching minority students judge these students to be of low ability and incapable of succeeding in science and math. The National Science Board Commission (NSB) on pre-college education in mathematics, science and engineering stated that

> There are far too many performance disparities in mathematics and science of students from disadvantaged populations, both urban and rural, who lag far behind their peers. These disparities start as early as kindergarten, persisting across grades, and in most cases widen over time. (p. 2)

Minority grouping into slow-track classes increases the student's beliefs that they are not capable of doing well in science and mathematics and in other subjects. Oakes (1990)

found that two-thirds of all classes in secondary schools with high minority grouping were found to be low-ability. More than half of the majority White classes were found to be high-ability classes.

Access to Science and Math Programs

Access to science and math classes poses another achievement barrier by minority students. Oakes (1990) stated that "Access to high-track science and mathematics classes diminishes as the minority enrollment at their schools increases. Second, those who attend racially mixed schools are more likely than their White peers to be placed in low-track classes" (p. 25). Supporting this 16 years after the Oakes report, the National Science Board Indicators (NSBI, 2006) showed that

> There remains growing inequality of K–12 students' access to solid science and mathematics education, as well as the necessary science and mathematical courses and prerequisites for entering colleges and universities. This will threaten to widen the educational gap that already exists between different economic strata and between the Nation's majority and growing minority population. Many students are faced with a lack of challenging courses, while other students, especially black and Hispanic minorities and students in rural areas, are not offered or are discouraged from taking such courses. (p.5)

Science curriculum, teaching, and the quality of instruction make a difference to not only what students learn, but how they perceive the subject in their future educational choices. Generally, students beginning in kindergarten, are taught basic science and math by teachers not trained in these areas as specialties of education. Many teachers are not themselves comfortable or qualified to teach these subjects, and may spend the least time necessary teaching these subjects (Goodlad, 1984; NSB, 2006). Oakes (1990) found that schools with high enrollments of minorities had either larger class sizes or had fewer sections of science and math classes than the schools that had a majority of White

students. The schools with mostly White students had science and math classes that were smaller in size. More sections of these classes were also available.

Schools offering classes in the sciences and math, if they are not available to minority students, may also hinder a student's ability to learn that subject and influence whether the student continues to take courses in that field. High schools with a high enrollment of minority students offered fewer classes in science and math, including advanced classes in those subject areas (Ekstrom, Goertz, & Rock, 1988; Jones, 1984; NSB, 2006)

Access to Qualified Teachers in Science and Math

The NSB (2006) report indicates that children having teachers with knowledge and skills to teach science and math effectively in the K-12 system are more likely to succeed in these areas and close the achievement gaps, and may be more prepared to choose careers in these areas. The number of middle and high school teachers certified in science and mathematics is down, as per the report. In addition, college graduates entering the teaching profession in these areas have fewer academic skills. Nationally, between 17% and 28% of public high school science teachers, and 20% of mathematics teachers, lacked full certification in their teaching field in 2002; the problem was proportionally higher for middle grades. Stern (1994) reports that "out-of-field teaching is most prevalent in rural and urban districts and high poverty areas" (p. 34). In the report by the National Commission on Mathematics and Science Teaching for the 21st Century (2000) rural and urban districts reported the most difficulty in hiring and retaining well-qualified and skilled mathematics and science teachers. Well qualified teachers in these areas predominantly teach in White majority better-to-do schools.

America's college faculty is still representative of mostly White majority instructors. Minority group instructors are less likely to have chosen teaching professions, especially in science and math (NSB, 2006). In addition, Trower (2002) indicates that the predominant White culture has forced upon minority groups the idea that to succeed, to acquire tenure and to be accepted is to assimilate into the White traditional setting and culture. This implies that the minority group's own culture and views should be abandoned. This has been discouraging to many minorities who may have wanted to enter education as a career. The shortage of role models in science and math education is also a barrier (Schuhmann, 1992).

The NSB (2006) report indicates that students who have teachers qualified to teach science and mathematics, and who have the skills to teach effectively in these areas are more likely to succeed in these areas. Nationally, the number of certified teachers in these subjects is decreased, and further, teachers who teach in inner city and predominantly minority schools are most likely not certified to teach in science and math. Teacher turn-over is high, particularly in schools with high minority enrollments such as inner city schools (Darling-Hammond & Hudson, 1989; NSB 2006). Oakes (1990) indicates that teachers in schools with high minority student populations lack interest and insufficient science and math background to teach effectively. In essence, these minority students are being taught by teachers who lack interest and are less qualified than the majority White students who are taught by more qualified teachers, and who are better prepared.

The NSB (2006) report indicates that "nationally between 17% and 28% of public high school science teachers, depending on field, and 20% of mathematics teachers

lacked full certification in their teaching field" (p. 5). These teachers are more prevalent in schools with high minority student enrollments.

Advance placement (AP) classes are usually taught by highly qualified teachers who are knowledgeable in the subject area. Low-track classes have a higher probability of being taught by teachers who do not have the skills to teach science and math. Some inner city schools may have AP classes; however, they still may not have qualified teachers for those classes. Attracting highly trained and skilled teachers into inner city and predominantly minority schools is difficult (NSBI, 2006). Though not a scope of this study, low salaries also contribute to the lack of qualified teachers and inability of inner city schools to attract and retain teachers. The NSB (2006) Report reported that about 22.5% of science and mathematics teachers who left the profession between 2000 and 2001 reported they did so for better salary and benefits.

Access to Resources

Inner city schools and predominantly minority enrolled schools have fewer resources than do more affluent schools. These include computers and other technologies. Teachers and administrators in these schools report that the lack of resources interferes with teaching and effectiveness (Greenswald, Hedges & Laine, 1996; NSB 2006; Oakes, 1990; Wang, Haertel, & Walberg, 1997). Lack of software, computers and other relevant teaching tools impedes with teaching pedagogy. The lack of resources includes older and lower quality texts being used in the classroom.

The disparity of resources grows as the level of school age increases. The disparity between the affluent schools and the inner city schools are much wider in high schools than seen in the elementary schools (NSB, 2006; Oakes, 1990). Though the No

Child Left Behind Act (2001) continues to maintain parity for all children, this has not occurred (NSBI, 2006). Oakes (1990) found that racial composition in schools was a large factor in the availability of resources. Elementary schools with large Black and Hispanic populations had, on an average, fewer resources than the schools with majority White students. In particular, high schools science laboratories were less equipped than the counterparts in affluent schools. Science laboratories include technologies in addition to computers such as microscopes and other equipment used in experiments. In addition, staffing was reduced in schools with high minority populations. Laboratory coordinators and staffing were not as abundant if at all in inner city schools.

Geographical location is a contributing factor as well. Inner city schools have fewer resources than suburban schools. Students in lower socio-economic areas, high minority inner city schools, have fewer resources in schools that affect the quality of instructional tools available to students in science and mathematics.

Access to resources and opportunities in the classroom, therefore, are limited and is a multi-faceted problem, involving resource allocation, funding, and distribution of tools throughout the educational system. The result is that more affluent students, who already have an advantage from kindergarten in how they are perceived and are placed, are given the greater opportunities to have the better resources for learning.

Opportunities in the Classroom

Disparities in access to quality schools and educational opportunities based on segregation and resources are barriers to student achievement (Springer, 2001). The particular courses that students take, particularly in high schools, affects their achievement in science and in college classes (Jones, 1984; NSB, 2006). If a school does

not offer a class, such as chemistry, biology, or other science courses, this limitation will affect what a student learns. Another contributing problem is that of advanced preparatory (AP) classes. The more affluent a school is, the more AP classes are offered. Schools with high minority populations had few if any AP classes in sciences and math (Oakes, 1990). The NSB (2006) report indicated that

> There remains the growing inequality of K-12 students' access to solid science and mathematics education, as well as the necessary science and mathematical courses and pre-requisites for entering colleges and universities. This will threaten to widen the educational gap that already exists between different economic strata and between the Nation's majority and growing minority population. (p. 4)

Courses that are either considered gatekeeper or pre-requisite courses are also an additional contributing barrier to minority student achievement in science and math. These courses are usually the base or fundamental courses by which other courses build their knowledge from. For example, high school calculus and biology are considered gatekeepers. If these courses are not available to students in high school, if they attend college, they must first begin their higher education by taking these as fundamental courses. The NSB (2006) report also indicates that minority Black and Hispanic students are also discouraged from taking challenging science and math courses. The problem extends even further from that of high school education. Middle schools that do not offer gatekeeper courses prevent students from choosing the next sequential course in high school. If geometry or basic algebra are not offered, or have limited sections that minority students do not take, then they cannot continue in this stream of education in high school. Schools with a predominant White student population offer more opportunities to take these courses, both in the middle school and in high schools.

In addition, the rigor of the instruction also may be a limiting factor (NSB, 2006; Oakes, 1990). For example, advanced placement classes have higher levels of instruction and teachers instructing these courses have higher credentialed qualifications. Since minority students may already be placed in low-track classes, AP classes are usually not available to them. Classes with higher levels in teaching and rigor are more available to students in the White majority who have already been afforded educational advantages throughout the K-12 years. Minority groups, whether in inner city schools or elsewhere in other schools, are usually not afforded as many advantages to take on higher level science and math classes. This in turn may limit their continuing their education and interest in these areas. Studies show that student achievement and even motivation, improve when teachers instruct using methods that match student learning style preferences and that shifting instructional methods by instructors can be accomplished (Dunn, Griggs, Olson, Gorman, & Beasley, 1995; Felder, 1993; Wakefield, 1993). A study by Murphy, Gray, Straja and Bogert (2004) on learning style preference in dental students showed that students who were taught by instructors who used teaching methods in congruence with those of the learning styles had better achievement. This are in education warrants the need for additional research, particularly with minority students due to the limited available data.

Summary

The National Science Board Science Indicators report (2006) shows that changes have not occurred regarding performance in science in K-12. In addition, performance disparities continue to increase between minority groups, usually underrepresented in the

sciences, and the White majority students. Disparities are seen as early as kindergarten and increase as school age increases. As discussed in this chapter, achievement in courses and programs is higher in White students from those of minorities.

Research suggests that learning style preference and its implementation is an important factor in student achievement (Cano, 1999; Cano & Garton, 1994). The results from this study could reveal that minority groups may have learning style preferences that if pedagogy and teaching strategies are implemented for them, may result in increased student performance and achievement. Given the science career shortages, students from minority groups can be encouraged to succeed in science classes by using learning style information for the benefit of teaching strategy implementation. For example, the observant sensor student could benefit from doing experiments and the intuitive learners can 'think and theorize', while the active learner can benefit from active group work and the reflective learner can do individual research and design.

All instructors want their students to learn that is why teachers teach. However, they may not know how to teach students, particularly students who come from minority groups with cultural differences and some with varying languages. Knowing how to begin to reach out to students may enhance the number of minority groups entering science careers. Increasing achievement in class performance may increase the number of minorities in science careers and will enrich and strengthen the diversity in the scientific community.

Research on the adult learner has revealed that adult learners want to know how to learn best and that instructional strategy that matches their learning styles can enhance learning and achievement. Limited research on minority adult students exists particularly,

in science classes. Studies show that learning is improved when matches occur between the learner and the instructional strategy. However, research focusing on the relationship between the learning style preference and achievement in the adult minority student is limited and virtually nonexistent. In addition, research focused on these students in science classes is also scarce. Thus, this study attempted to add to the body of knowledge in investigating the relationship between learning style preference and student achievement in minority groups. Given the science professional shortage and low achievement by minority groups in this area, the study significantly adds to the body of information that could be used to increase minority achievement in science classes. Ultimately, more minorities might choose scientific or science-related careers.

CHAPTER 3:

METHODOLOGY AND DESIGN

Introduction

Chapter 3, methodology and design, discusses information about the research questions and hypotheses, research design, variables, population, sample, the instrument, data collection methods, and the method of data analysis. The limitations, delimitations and validity of the learning style inventory instrument are incorporated into the discussion of the instrument.

The purpose of this study was to examine the relationship between learning style preferences and achievement (grades) by adult minority students in a multicultural college. The specific populations investigated were: Hispanics, Blacks and other minorities. Minorities traditionally do not enter science careers. As examined and discussed in chapter 2, the barriers that exist both at the college level as well as in the home environment, decreases minority enrollment in the sciences. The researcher was interested in obtaining data regarding learning styles and achievement so that recommendations can be provided regarding maximizing student achievement. The intent of the information generated or gathered from this study was to increase student achievement in the area of sciences, thereby encouraging minority students to enter into scientific careers.

As a foundation to the methodology design, the Felder-Soloman Inventory of Learning Styles (ILS) was the research tool that was used with adults for the purpose of this study; to examine the relationship between learning style preferences and achievement (grades) by adult minority students in a multicultural college. Students

observe, process, and retain information in different ways. Students have different learning styles and in the educational forum, faculty should be helping students build skills not only in their educational field of study, but in their preferred learning method. Teachers also have different teaching styles. Mismatches may occur between student learning styles and teaching styles. When this happens, students may not do well in class, and achievement decreases. The matching of student LSI to teacher learning styles may affect student achievement. However, the first step is to ascertain how students learn and particularly, minority students, who usually have lower achievement rates than Whites in science classes (National Science Foundation Workshop Report, 2007). Understanding how college students learn (Anderson and Adams, 1992) and that students have different cognitive skills and learning styles at the college level needed to be better understood. The study design used the Felder-Soloman survey (1996), which was developed using the Felder-Silverman dimensions of learning styles, for ascertaining student learning styles. The ILS classifies students in the Felder-Silverman dimensions. The Felder and Silverman (1988) learning style dimensions were based on some previously ascertained models and new concepts to provide teachers with teaching styles that may be better suited to teach the students once their learning styles are known. Jung's (1971) psychological theory of perception and Kolb's (1984) learning style theory relating to how students process information contributed to the Felder-Silverman learning style dimension model.

Research Questions and Hypotheses

The research design was based on gathering data to determine the relationship between the learning styles of the adult minority student and achievement (grades). Based on the purpose of the study, the questions were based on quantifying the data gathered in order to obtain information for the use of best applied learning techniques for student achievement. All students within the sample were invited and encouraged to participate in the study. However, the main emphasis was the minority student population preferences.

Questions that identify learning style preferences were asked in the chosen survey.

The following research questions were addressed.

1. Which learning styles are evidenced by minority college students as measured by the Felder-Solomon Learning Style Inventory?

2. What is the relationship of preferred learning style preferred and achievement as measured by grade obtained?

3. What is the relationship between a learning style and a minority group defined by the college's demographic questionnaire?

4. What is the relationship between achievement and minority group defined by the college's demographic questionnaire?

The hypotheses that were relevant to the research questions were:

Since Research Question 1 is descriptive, there is no hypothesis for this question.

Null Hypothesis 2: No relationship exists between preferred learning style and achievement as measured by grade obtained.

Alternative Hypothesis 2: A relationship exists between preferred learning style and achievement as measured by grade obtained.

Null Hypothesis 3: No relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Alternative Hypothesis 3: A relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Null Hypothesis 4: No relationship exists between achievement and minority group defined by the college's demographic questionnaire.

Alternative Hypothesis 4: A relationship exists between achievement and minority group defined by the college's demographic questionnaire.

Research Design

A quantitative study design was chosen to test the relationship between learning style preference and student achievement in minority students in a South Florida multicultural college in biology classes. The study was a quantitative method design using a survey instrument, the Felder-Soloman ILS.

This method also allowed a large number of participants to be surveyed from a small group of individuals. The quantitative design proposed for this study was that of a modified one-shot case study (Creswell, 2003), Creswell stated

> A quantitative approach is one in which the investigator primarily uses postpositivist claims for developing knowledge (i.e., cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories), employs strategies of inquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data. (p.18)

The student personal demographics were obtained from a three item questionnaire in which the student checked off gender, ethnicity, and race. The questions relating to ethnicity and race minimized confusion for the participant. Though some students may have bi-ethnicities or bi-racial identities, for the purpose of this study, the responses were maintained so that the student would respond to the ethnicity and race that is most predominant in the student's culture. Each student was provided a number for identity, which was the number ID the student used in the name section on the ILS. The demographics questionnaire was given to the student with the pre-assigned number to minimize transposition of the number ID by the student. The faculty member in each course had the student number and was also be the only person who knows the student name. Assignment of the number for the student was done by the faculty.

Variables

The independent variables in this study were the learning styles, ethnicity, and race. The independent variables were based on Felder's (1996), categories of learning styles, and correlating the preferred styles in the minority groups. The dependent variable was the student achievement measured in this study by the grade obtained at the end of the course, which was a 16-week term. The dependent variable, student achievement as measured by the overall grade, was based on an A-F scale (A = 90-100; B = 80-89; C = 70-79; D = 60-69; F < 60).

This study was designed to gather information pertaining to minority groups, particularly Hispanics and Blacks within the institution. Additional information regarding other races was obtained, from Institutional Research Department, which the researcher

was able to compare data along with White student achievement. The final evaluation of the data obtained through statistical analysis was used to recommend the most appropriate learning style(s) for minority groups.

Population and Sample

The population used for this study consisted of adult students enrolled in biology courses at a South Florida multicultural college. The college has multiple campuses and satellite centers. All the campuses are congruent with respect to the student body, resources, and all other college-life amenities. The course subject was selected because of ease of accessibility by the researcher, the subject interest, and need for science majors and careers. The population of the study was comprised of students in on-campus biology courses at the college.

After the Institutional Research Board approved (No. 11-02-07-318065), the study was conducted in the fall semester (August-December) with an approximate population of 540 students. The typical approximate enrollment of biology students during each of the long semesters is (fall or winter) is approximately 500-600 students. Biology courses are also offered online, for consistency in teaching forums, only on-campus classes were used for selection. The college where the study was conducted has three formats for the biology course: on-campus, Web-enhanced, in which a component of the course in on the Web, and fully online. Only the on-campus classes were used. The other classes added a variable, which was not within the realm of this study.

The design for this study was single-stage and cross-sectional, with information collected one point in time in each of the courses selected. Classes were chosen at

random using a lotto style method in which reference numbers for the biology courses were selected. All the biology courses had a reference number. The reference numbers were written on a piece of paper for all the sections of this course and placed in a box. The researcher blindly selected each paper and wrote the reference number down. This continued until the appropriate number of classes was chosen. The number of classes drawn from the lotto style method depended on the total sample needed. The total number of classes was not known until the end of the 100% refund period at the college which is 1 week after the onset of classes each semester. The usual enrollment was approximately 30 students per class. The final number of students at the end of the 100% refund period determined the final number of randomly chosen classes using the lotto-style method.

The faculty teaching the biology courses selected were asked to participate in the study. The student participants were also on a volunteer basis and anonymity was maintained. Both faculty and students in the randomly chosen classes were asked to participate. They had the option to participate or not being that participation was voluntary.

Using the Pearson Calculator for a population of (540) respectively, (n = 540), the sample size of 224 students was selected from randomly chosen classes in this subject. The final size of the sample was determined using the number of classes that were kept and not canceled in the semester. The final sample number was dependent on the final student population determined at the end of the 100% refund period. Calculation of the sample was done for a 5% error and a 95% confidence level. The actual sample size was determined using the sample size calculator for 5% error and a 95% confidence level and

the actual enrollment in the course in the semester in which the study was conducted. Grades were obtained at the end of the semester and provided by the instructor in the courses.

The Instrument

The method used in this study involved the use of the Felder-Soloman (ILS) Index of Learning Styles (2000). The instrument is also referred to as the Learning Style Inventory (LSI) by Felder and Soloman (1999). The survey was developed using the four learning style dimensions of the instrument adapted from a learning style model developed in 1988 by Felder and Silverman. The first version of the instrument was administered, and the data gathered was statistically analyzed. The original ILS was modified, and additional questions were added to obtain the current version of the instrument. The ILS was uploaded to the web site on the Internet in 1996.

The Index of Learning Styles is an online instrument used to assess preferences on four dimensions (active-reflective, sensing-intuitive, visual-verbal, and sequential-global) of a learning style model formulated by Felder and Silverman (1993). The college has electronic classrooms that can be used to take the survey. The researcher and the instructor assisted students who were not technologically adept in logging onto the ILS web page. The ILS Inventory was easy to take. The student needed to click with the mouse on the answer corresponding to the question. At the end of the Inventory, a submit button was clickable as well.

The instrument was designed to process information in different ways: seeing and hearing, reflecting and acting, rational reasoning and intuitive reasoning, and analyzing

and visualizing. Though the actual learning styles include a fifth area: inductive/deductive reasoning, Felder (2006) does not include this in the ILS because, as he stated on the Web site, “the best method of teaching at least below the graduate school level is induction, whether it be called problem-based learning, discovery learning, inquiry learning, or some variation on those themes.” (quest. 11)

The instrument was developed by Soloman and Felder (1999) and available through the Internet. The instrument was developed using the Felder-Silverman dimensions of learning (1993). Students did the inventory online. If no electronic classrooms were available at the time that a biology course was scheduled, the students did it using their computers from home. Occasionally, electronic classrooms have scheduled courses and it may be impossible for another class to meet in that classroom, though every effort will be given to schedule as many courses in the electronic classrooms. The students invited to participate could go online from home or another computer and do the inventory. In this particular case, the researcher provided a timeframe for students to complete the Inventory and return the results to their instructor. Providing a timeframe or deadline allowed the researcher time to return to the classroom and request participation if needed in case insufficient samples were returned.

The online ILS had immediate results for the students. Once the students filled in the inventory and submitted the answers, an immediate result was provided. The results were based on a scale which is shown as follows.

11 9 7 5 3 1 1 3 5 7 9 11

The instrument was designed to provide input on a negative-positive scale. Felder (2001) mentions that this is used to add up the individual areas within the instrument

questions. They do not reflect the student learning style preference as a positive or negative number, but that of the addition and subtraction of question sums. The method by which the computerized version scores is simple and provides the data already scored without the use of long-hand computation.

The students received their ratings and an explanation of the ratings. If the Inventory was done in an electronic classroom, the researcher obtained the results at the time the student submits the response. However, if the student had to do the Inventory from home, the researcher obtained the result from the instructor.

No payment was incurred for printing the results by the students. Every student was assigned a number by the researcher. The number was placed in the 'name' box of the ILS and the demographics sheet. The number corresponding to the student name was only known to the instructor. In this way, at the end of the semester, when the final grade was computed, the instructor provided the researcher the student's final grade by 'number' relationship. The researcher was able to compute the relationship of student achievement measured by grade to the student learning style preference.

The ILS was also available to students via hard copy format and computed using a key. The researcher used the computerized version only. Permission to use the instrument was obtained from the Internet site, in which Felder (2006) stated in response to the question of whether a researcher may use the ILS Instrument.

> You are welcome to do so. If you use it and/or publish anything related to the instrument or data obtained with it, the proper citation must be included with this as per the instructions on the web site: (Richard M. Felder and Barbara A. Soloman, *Index of Learning Styles*, <http://www.ncsu.edu/felder-public/ILSpage.html>, accessed November 15, 2007. (quest. 5)

In brief, the following indicates the steps for the design of the research study.

1. Research on Learning style inventory and selection of Felder-Soloman ILS model as the most appropriate.

2. Population and sample size selected and determined.

3. Participants selected through a random selection of biology courses.

4. Participation of faculty and students was on a voluntary basis.

5. Participants were asked to complete the ILS and provide the demographic data using a Number for Identification.

6. Participants completed the ILS within the time frame of their class.

7. If an electronic classroom was not available, the student was asked to complete the ILS from their home computer within one week and provide the instructor with the ILS result (hardcopy printed format). Instructions provided information in written format for the student to follow so that they log into the web site and complete the ILS.

8. Instructors provided to the researcher the final grade corresponding to the student's identification number, thereby maintaining student anonymity.

The Felder-Soloman Learning Style Index was used to determine the learning styles. A copy of the ILS is found in the Appendix A (Soloman-Felder, 2000). The ILS classifies learners into four groups:

1. Active and reflective learners (ACT-REF): Active learners learn better by actively participating and discussing or applying it with others. Reflective learners learn better by thinking about things, preferably alone.

2. Sensing and intuitive learners (SEN-INT): Sensing learners learn better when presented with facts, and think more in practical ways. Intuitive learners learn best when

presented with the possibilities of innovation and relationships. They tend to work faster than sensing learners, who prefer to think things through more.

3. Visual and verbal learners (VIS-VER): Visual learners learn better when they see objects, pictures, diagrams, flow charts, and videos. Verbal learners, on the other hand learn better when they read words in a written fashion and when words are spoken. Listening is a preferred method of learning.

4. Sequential and global learners (SEQ-GLO): Sequential learners learn better when subjects are presented in a linear manner. Each step follows another, and therefore, it forms a logical sequence. Global learners learn best when they are able to go from one area to another, to use information in a nonlinear manner. These learners will jump from one item to another, and suddenly, the concept will 'click' and they will understand it. In other words, where sequential learners learn in a linear manner to understand the final product, the global learner will jump from one item to another, and be able to suddenly understand it all. Global learners may tend to be more apt at being able to solve complex problems in innovative ways. Since they tend to suddenly understand the problem or solution, they may not be able to explain how they came to the actualization of the product (Felder, 1999).

Reliability and Validity

Various studies verify the reliability of the ILS instrument (Felder & Spurlin, 2005; Litzinger, Lee, Wise, & Felder, 2005; Tate, 2003; Zywno, 2003). Threats to validity may exist which could skew results (Creswell, 2003). An internal validity threat could result if students, when given the survey, discuss the surveys while answering. One

way to reduce this threat was to apply the survey and monitor administration of it until filled in. External threats were reduced if the researcher clearly stated that the results pertain only to this specific student sample and population and not to others. The use of the data gathered in this survey to infer information to other groups should be avoided. In addition, though inferences can be suggested to other groups which are similar, these inferences would not be a threat to validity if it is clear that the results in this study may be applicable to other similar groups. Of importance and relevance, however, is the discussion regarding the information gathered in this study, which may reveal additional information regarding other minority group learning styles preferences.

Data Collection

Permission was requested from the college's vice president and approval was obtained for this study.

1. All the participants were college students enrolled in biology courses.
2. The number of students who completed the ILS was determined from the enrollment population at the time of the study.
3. The limitations of the study were discussed in chapter one.
4. The scoring guidelines were to click on the answer most appropriate for the individual student (online) and submit for a response.
5. The Felder-Soloman ILS Inventory was also provided in hard copy form. If a hard copy of the ILS was to be used, the scoring guidelines were as follows: (a) Place an "I" in the appropriate area on the score sheet where the answers are represented by only two choices: a. and b. If facilities were not available for the computerized version, the

researcher would (a) input the individual student's hard copy responses into the computer to obtain the scored result, and (b) actual long-hand scoring could be done. Using the following method, total the columns and write the totals in the indicated space: (a) for each of the four scales, subtract the smaller totals from the larger ones, and (b) the difference (1–11) and the letter (a or b) with the larger totals are written. For the purposes of this study, the electronic version of the ILS was used.

The researcher gathered all the completed forms/responses from the ILS and the individual demographics sheets. The demographic sheets already had a printed ID number on them. The results were listed in a data sheet. The faculty teaching the course supplied the researcher the final student grade at the end of the course with only the student number.

The time frame for the study in the semester entailed the following:

1. Random selection of participant classes (after the 100% completion date and the first week of the semester).

2. Contact of faculty in chosen classes and request to participate in study, (after the second week of the semester).

3. Attend class and request student participation. This was scheduled after weeks 4-6. Scheduling depended on the availability of electronic rooms as well as faculty participation and teaching schedules, including scheduled use of electronic class during timeframe of regularly scheduled class within the semester depending on availability. Also, completed ILS Inventories were immediately gathered if they were completed in an electronic classroom.

4. Alternate -- Attended class and requested student participation to complete ILS from home if an electronic class could not be scheduled.

5. Obtained from the instructor the ILS Inventories in classes where an electronic classroom was not obtained and students completed the Inventory and returned them to the instructor. The time frame for completion of the ILS was one week.

6. Obtained final student grades from instructor at the end of the semester (16 weeks).

Statistical analysis was done pertaining to the ILS. Statistical analysis on relationships to grades was done after the researcher received final student grades from the instructor.

Method of Data Analysis

The method of data analysis that was used in this study involved a quantitative method design that allowed relationship of the various independent variables to that of the dependent variable. The following quantitative methods were used: (a) descriptive statistics including frequency distribution tables and graphs. This tabulated the number of individuals in each category using the number of participants in sample and numbers who returned the survey, (b) nonparametric measures, (crosstabs and chi-square tests), and (c) parametric measures (analysis of variance, ANOVA). These tested hypotheses about the frequencies that were expected in a distribution. The tests were conducted on ethnicity, race (minority group), grades, and learning styles that tested hypotheses about the frequencies that were expected in a distribution. In addition, measures of relationship between variables, such as the ANOVA measured the degree of linear relationship

(learning style and grades, grades and minority group). Tables and charts were provided using SPSS, Excel, or Word Tables.

The methodology and data analysis was designed so that the researcher could gather data addressing the research study questions and test the hypotheses. Since question number one was not a relationship question, but a descriptive one, descriptive methods were used to analyze the data. Other quantitative methods were not appropriate for this study since other ones involved more than one sample, or treatment. This study involved one sample and was a one-shot study.

The purpose of this study was to test hypotheses that related student achievement and learning style preferences in minority college students. The results of this survey could be used to recommend to and assist faculty methods of teaching strategies that might better help student achievement in biology. This research can also be used to study students in other science and subject courses.

Table 1 addressed the four research questions in this study and the statistical application. General information such as grade distribution and ethnicity were analyzed and tabulated using SPSS and or Excel using statistical procedures and analysis.

Table 1

Statistical Applications to Research Questions

Research question	Statistical application	Data source
1. Which learning styles are evidenced by minority college students as measured by the Felder-Solomon Learning Style Inventory?	descriptive analysis, relative frequency	ILS Survey
2. What is the relationship of preferred learning style and achievement as measured by grade obtained?	independent measures analysis of variance (ANOVA)	ILS Survey Grades provided by faculty at the end of the course
3. What is the relationship between a learning style and a minority group defined using the demographics questionnaire?	chi square, crosstabs	The college's demographic questionnaire
4. What is the relationship between achievement and minority group defined by the college's demographic questionnaire?	independent measures analysis of variance (ANOVA)	The college's demographic questionnaire

Summary

Chapter 3 described the methodology that was used to conduct and analyze the data in this study. The purpose of this study was to seek to understand the relationship between learning style preferences and achievement (grades) by the adult student in the various ethnicities representative in a multicultural college. Specifically, this chapter described the process of examining the learning style preferences and student achievement between the minority groups in the sample. The goal of this study was to correlate student achievement and the use of learning style techniques amongst various ethnicities.

As a result of the study, recommendations for learning/teaching techniques for faculty use with these populations are made. Embedded in this study was an attempt to understand why minority groups do not succeed as well as Whites do in sciences and why minorities do not typically choose science careers. The predictions by the USDA (2005, 2006) and NSF Indicators (2006), on the shortage of scientists and the gap in minorities in this field is a major factor contributing to the rationale why this research study is imperative. In addition, the results of this study intended to pave the way for future studies in minority achievement in sciences and other subjects. This study also intended to affect the way instructors perceive their teaching, as this study opens up new research opportunities correlating different teaching style techniques with student learning styles. This was an innovative approach to the way faculty may be able to use their teaching styles because, by knowing the minority student population and understanding learning style preferences, adaptations in teaching techniques may improve student achievement. Not only are they underrepresented in the university system as faculty, but in research and development (NSF Indicators, 2006; USDA, 2005, 2006).

CHAPTER 4:

RESULTS

Introduction

The purpose of this study was to examine the relationship between learning style preferences and achievement, as measured by grades, by adult minority students in a multicultural college. The study involved a quantitative analysis using descriptive analysis and statistical methods to address learning styles, minority group (ethnicity and race), and grades. As addressed in the previous chapters, minorities traditionally do not enter science careers. The analysis of this study may have an impact on how students learn, are taught and succeed in college science classes. The results of this survey will be used to recommend to faculty, teaching strategies that might support learning and successful achievement by students in biology. This chapter presents the demographic information of both the college and majors biology classes, the data gathered using the Felder-Soloman ILS, and final grade of the students enrolled in the biology classes. The chapter is organized in several sections provides descriptive data on (a) the college's population and demographics, (b) population and sample demographics of students enrolled in the biology course, (c) sample of participants, and (d) data analysis using statistical methods.

A quantitative study design using statistical methods was chosen to test the relationship between learning style preference and student achievement in minority students in a South Florida multicultural college in biology classes. The study design used the Felder-Soloman ILS. The student demographics were obtained from a three item questionnaire in which the student selected gender, ethnicity, and race. The independent

variables for this study were learning styles, ethnicity, and race of the students. The independent variable of learning styles was based on Felder's (1996), categories of learning styles, and correlated with the preferred styles in the minority groups. The other independent variables were obtained from a demographic survey. The dependent variable was the student achievement measured in this study by the grade obtained at the end of the course, which is a 16-week term. Student achievement is measured by the overall grade, is based on an A-F scale (A = 90-100; B = 80-89; C = 70-79; D = 60-69; F < 60).

Chapter 4 provides the analysis of the following research questions:

1. Which learning styles are evidenced by minority college students as measured by the Felder-Solomon Learning Style Inventory?

2. What is the relationship of preferred learning style and achievement as measured by grade obtained?

3. What is the relationship between a learning style and a minority group defined by the college's demographic questionnaire?

4. What is the relationship between achievement and minority group defined by the college's demographic questionnaire?

The hypotheses relevant to the research questions were:

Since Research Question number 1 is descriptive, there is no hypothesis for this question.

Null Hypothesis 2: No relationship exists between preferred learning style and achievement as measured by grade obtained.

Alternative Hypothesis 2: A relationship exists between preferred learning style and achievement as measured by grade obtained.

Null Hypothesis 3: No relationship exists between a learning style and a minority group defined by the demographic questionnaire

Alternative Hypothesis 3: A relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Null Hypothesis 4: No relationship exists between achievement and minority group defined by the college's demographic questionnaire.

Alternative Hypothesis 4: A relationship exists between achievement and minority group defined by the college's demographic questionnaire.

The final section of the chapter will provide a summary of the data discussed.

College Demographics

The study was conducted at a South Florida college. The information provided in this area of this chapter was compiled from the internal college data gathering system from the Business Intelligence Department (2007) which gathers and provides data for the college. Each semester, enrollment may differ depending on various factors, such as the workforce economy, weather catastrophes such as hurricanes, and scholarship availability.

The demographics were obtained from the college's enrollment management obtained from the data management system. The data presented includes the independent variables, such as the gender, ethnicity, and race that were under investigation in this study. This information, however, represents the college's total percentages for these demographics. The total number of students enrolled at the college in the fall, 2007-08

Academic Year, earning college credits was 35,879. Table 2 demonstrates the breakdown of headcounts and percentages of students by ethnicities and race.

Table 2

Race and Ethnicity of College

Race	Headcount	Percentage
African American	10,176	28.5
American Indian	113	0.3
Asian	1,458	4
Unknown/Undeclared	2,383	6.6
White	21,749	60.6
Total	35,879	100
Ethnicity	Headcount	Percentage
Hispanic	10,676	29.8
Non-Hispanic	25,203	70.2

As Table 2 demonstrates, the percentage of White students outnumber African American students, while Hispanic students, used as an ethnic group, is 29.8% of the ethnicity of the college. Both African American students and Hispanics comprise 58.3% of the student overall population of the college.

Population of Students in Biology

The population for the study was comprised of students in majors biology courses at the college. Majors biology courses are gateway courses that students must take if they are going into scientific or science related fields. Majors biology classes were chosen in the study because many students intending to go into scientific or science related fields must enroll and successfully complete these courses. The population of students in the biology courses was obtained using the total enrollment for the course in the semester in which the study was conducted. The population number was obtained from the college's

enrollment management data obtained from the data management system. The population was obtained after the 100% withdrawal date, allowing accurate figures of students counted as officially enrolled in the courses. The population size obtained was that of 524 students.

Demographics of the college and enrollment in biology courses were analyzed using Descriptive Statistical Methods. The independent variables of learning styles, gender, ethnicity and race are presented in a later section of this chapter. Data categories for the demographics were obtained from the US Census (2005) criteria. Table 3 provides the race and ethnicity of students enrolled in the majors biology courses. The compilation of this type of information is relatively recent at the college.

Table 3

Race and Ethnicities of Students Enrolled in Biology

Race	Headcount	Percentage
African American	124	23
American Indian	2	0.4
Asian/Pacific	54	10
Unknown/Undeclared	27	5
White	333	61.6
Total	540	100
Ethnicity	Headcount	Percentage
Hispanic	167	30.9
Non-Hispanic	373	69.1

Comparison of race and ethnicity between the total student body and those enrolled in majors biology courses is shown in Table 4.

Table 4

Race and Ethnicity Comparison of College and Majors Biology

Race	Total College Percentage	Majors Biology Percentage
African American	28.5	23
American Indian	.3	0.4
Asian/Pacific	4	10
Unknown/Undeclared	6.6	5
White	60.6	61.6
Total	100	100
Ethnicity	Total College Percentage	Majors Biology Percentage
Hispanic	29.8	30.9
Non-Hispanic	70.2	69.1

Analysis of the percentages represented in Table 4 shows that Hispanics enrolled in Biology exceed the total college percentage of Hispanics by 1.1%, and 5.5% fewer African American students enroll in these classes. A slightly higher proportion of Whites enrolled in biology (1.0%) than the average White percentage for the college.

Enrollment in biology courses demonstrate interest in the field, however, low achievement rates in minority students enrolled in these types of courses as presented in the National Science Foundation STEM Report (2005) deter students from further advancement in scientific courses and careers. Many of the students enrolling in biology courses enroll as a pre-requisite to nursing programs, not as science career potentials. Achievement rates of students enrolled will be compared in a subsequent section in this chapter.

Survey Sample

The population used in this study consisted of adult students enrolled in majors biology courses at a South Florida multicultural college. The study was conducted in the fall semester with a population of 524 students. The population of students was representative of the student composition since all students who wish to enter into science or science related careers must enroll in these courses. Since biology courses are also offered online, for consistency in teaching forums, only on-campus classes were used for selection.

The design for this study was single-stage and cross-sectional, with information collected one point in time in each of the courses selected. Classes were chosen at random using a lotto style method in which reference numbers for the biology courses were selected. All the biology courses had a reference number. The reference numbers were written on a piece of paper for all the sections of this course and placed in a box. The researcher blindly selected each paper and wrote the reference number down. Student enrollment in the courses ranged from 24–37 students. Six classes were drawn initially and the total number of students tabulated. The number of students in each class was added which equaled 201. The number was not enough for the sample needed. The researcher chose at random an additional class to increase the number. This last class had an additional 34 students providing a total sample of 235 students.

Since the college in which the study was conducted is a community college, faculty teach an average of 5 lecture courses per term. In total, there were 8 faculty teaching the 20 lecture classes of biology offered in the term. This did not account for

faculty teaching the labs which were not used in the study. A total of five faculty participated in the study.

The population of 524 was used to determine the sample size using the Pearson Calculator, for a population of (524), (N = 524), the sample size of 222 (n = 222) students was selected from randomly chosen classes in this subject. Calculation of the sample was done for a 5% error and a 95% confidence level. The sample size that was calculated using the Pearson Calculator was 222 students for a 5% error and a 95% confidence level.

The faculty teaching the biology courses selected were asked to participate in the study. The faculty selected agreed to participate and the students were provided with the informational letter, as well as clear instructions on how to complete the survey. The student participants were on a volunteer basis and anonymity was maintained. Only one class participated in electronic classroom use. The other surveys were done by students using their own computers or using computers in the learning resource center at the college. As described in Chapter 3, taking the survey could be completed by the class attending an electronic classroom, students taking the survey at home, or using the learning resource center. The students printed the results of the ILS survey.

Faculty assigned each student a number in accordance with the procedure. Each student used the assigned number to complete the demographics questionnaire and the ILS survey. The instructor attached the questionnaire and the survey together if the student had completed the survey at home or in the resource center. The instructor provided the researcher with the completed and attached forms. Grades were obtained at the end of the semester and provided by the instructor in each of the courses.

The entire faculty asked to participate in the study agreed to do so. A total of 235 students were asked to participate and provided with the information to take the demographics questionnaire and the ILS. The sample size that was calculated using the Pearson Calculator was 222 students for a 5% error and a 95% confidence level.

A total of 162 surveys were completed and given to the researcher by the faculty who participated in the study. This accounted for 73% return.

Table 5

Survey Numbers

Sample Needed	Surveys Needed for 70% Return $n = 222$	% Completed Surveys	# Completed Surveys	# Unreturned Surveys	# Participants
222	156	73%	162	73	235

The Instrument

The method used in this study involved the use of the Felder-Soloman ILS. It is also referred to as the LSI by Felder and Soloman (1999). The ILS is an online survey instrument used to assess preferences on four dimensions (active-reflective, sensing-intuitive, visual-verbal, and sequential-global) of a learning style model formulated by Felder and Silverman (1993). The ILS Inventory was not difficult to complete for participants. The student clicked with the mouse on the answer corresponding to the question. At the end of the Inventory, the student clicked on a submit button allowing printing of the results. The results of the survey were based on a scale. Students were able to take the survey both in electronic classrooms as well as from personal computers. They presented the results to their instructor.

The ILS classifies learners into four groups:

1. Active and Reflective Learners (ACT-REF): Active learners learn better by actively participating and discussing or applying it with others. Reflective learners learn better by thinking about things, preferably alone.

2. Sensing and Intuitive Learners (SEN-INT): Sensing learners learn better when presented with facts, and think more in practical ways. Intuitive learners learn best when presented with the possibilities of innovation and relationships. They tend to work faster than sensing learners, who prefer to think things through more.

3. Visual and Verbal Learners (VIS-VER): Visual learners learn better when they see objects, pictures, diagrams, flow charts, and videos. Verbal learners, on the other hand learn better when they read words in a written fashion and when words are spoken. Listening is a preferred method of learning.

4. Sequential and Global Learners (SEQ-GLO): Sequential learners learn better when subjects are presented in a linear manner. Each step follows another, and therefore, it forms a logical sequence. Global learners learn best when they are able to go from one area to another, to use information in a nonlinear manner.

In all dimensions, the learning styles are a dichotomy of learning and are continuous without extremes necessarily, but a stream from one end to the other (Felder, 1993, p. 286). The results were based on a scale as follows.

11 9 7 5 3 1 1 3 5 7 9 11

Felder (1996) added an additional classification to the previous four: inductive-deductive learning as an aspect of his learning model, however, the ILS does not test for this category. Deductive teaching is used mostly in undergraduate science teaching (Felder,

1993), with the best method of teaching below the graduate school level being that of induction (Felder, 2007). Felder stated

> Barbara Soloman and I don't want instructors to be able to give our instrument to students, find that the students prefer deductive presentation, and use that result to justify continuing to use the traditional deductive instructional paradigm in their courses and curricula. We have, therefore, omitted this dimension from the instrument. (quest. 11)

The ILS, therefore, surveys only the four other dimensions. Results of the survey are provided in this chapter in a subsequent section.

The demographics questionnaire was given in class and each student used their code name provided by their instructor. Each student also used the same code when they completed the ILS. The instructor collected both the questionnaire and the ILS and stapled them together. They were in turn given to the researcher for analysis. Grades were provided by the faculty at the end of the semester for each student who had participated by the code.

Demographics Questionnaire

The demographics questionnaire contained requested information for the independent variables of ethnicity and race. The questionnaire was obtained from the college's human resource department. The classifications for race and ethnicity were obtained from the US Census Bureau (2000). The demographics questionnaire was given to 235 students in the randomly chosen classes. There were 162 completed questionnaires returned to the instructors and the researcher. This provided a 73% return of completed questionnaires. The questionnaire contained the following race categories: White, Black or African American, Asian, American Indian & Alaska Native, Native Hawaiian &

Other Pacific Islander, and, some other race alone. The questionnaire categorized ethnicity as follows: Hispanic and non-Hispanic. The questionnaire included gender though the information is not pertinent to the questions asked in the dissertation.

The entire returned questionnaires consisted of 162 respondents. Table 6 provides the summary information for the demographics questionnaire for the 162 surveys returned (n = 162) for the 73% response rate.

Table 6

Demographics Respondent Summary

	Respondents					
	Included		Excluded		Total	
	n	Percent	*n*	Percent	*n*	Percent
Gender Race Ethnicity	162	100.0%	0	0.0%	162	100.0%

Table 7 provides the frequency and percent of race information. The information provided showed that 46.3% of respondents were White, with the percentage of other races less than that of Whites.

Table 7

Race of Respondents

Race	Frequency	Percent
White	75	46.3
Black- African American	51	31.5
Asian	11	6.8
Native Hawaiian-Pacific Islander	1	0.6
Other Race Alone	24	14.8
Total	162	100.0

Table 8 provides information on the gender of the participants. There were 34 male students (21%) and 128 female students (79%) who participated in the study.

Table 8

Gender of Respondents

Gender	Frequency	Percent
Male	34	21.0
Female	128	79.0
Total	162	100.0

Table 9 provides information on the gender by the race of the participants. Race and ethnicity were important criteria for this study.

Table 9

Gender by Race of Respondents

		Race					Total
		White	Black-African American	Asian	Native Hawaiian-Pacific Islander	Other Race Alone	
Gender	Male	16	11	2	1	4	34
	Female	59	40	9	0	20	128
Total		75	51	11	1	24	162

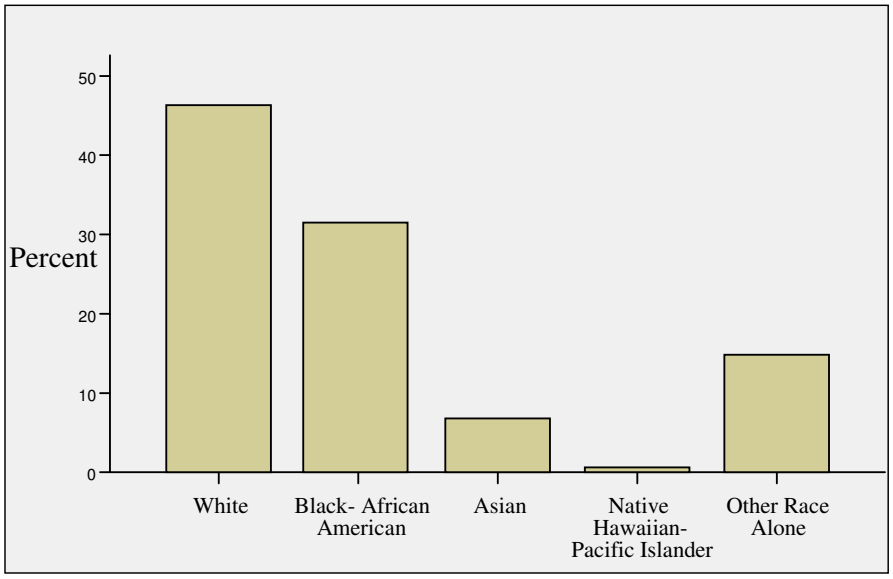

Figure 1. Race of respondents. Summary of the data for race obtained from the demographic questionnaire.

Ethnicity was defined by the US Census Bureau (2000) into Hispanic and non-Hispanic.

Table 10 provides information on ethnicity.

Table 10

Ethnicity of Respondents

	Frequency	Percent
Hispanic	51	31.5
Non-Hispanic	111	68.5
Total	162	100.0

In the category of Ethnicity, 31.5% of the respondents were Hispanic and 68.5% were non-Hispanics.

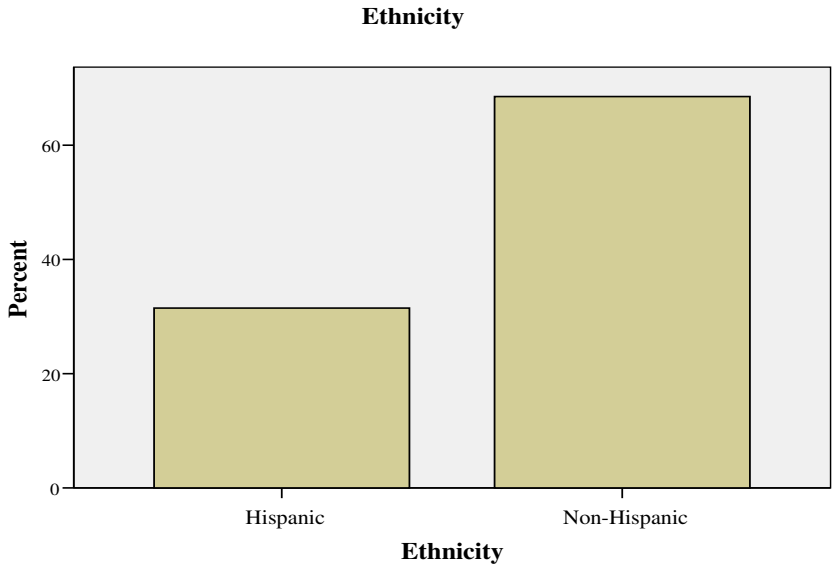

Figure 2. Ethnicity of respondents. Summary of the information on ethnicity obtained from the demographic questionnaire.

Table 11 provides summary information based on the various races and ethnicities. This table demonstrates the respondent information for race by ethnicity and provides the percentage of both in the returned questionnaires. The demographic breakdown of the respondents was: Whites comprised 46.3%, Black- African American, 31.5%; Asians 6.8%, Native Hawaiian-Pacific Islander .6%, and other races alone 14.8%. The percentage for Hispanics was 31.5% whereas that of non-Hispanics was 68.5%.

Table 11

Race and Ethnicity

Race	Ethnicity	*n*	% of Total *n*
White	Hispanic	29	17.9%
	Non-Hispanic	46	28.4%
	Total	75	46.3%
Black- African American	Hispanic	1	0.6%
	Non-Hispanic	50	30.9%
	Total	51	31.5%
Asian	Non-Hispanic	11	6.8%
	Total	11	6.8%
Native Hawaiian-Pacific Islander	Hispanic	1	0.6%
	Non-Hispanic	0	0.0%
	Total	1	0.6%
Other Race Alone	Hispanic	20	12.3%
	Non-Hispanic	4	2.5%
	Total	24	14.8%
Total	Hispanic	51	31.5%
	Non-Hispanic	111	68.5%
	Total	162	100.0%

Research Questions

The demographics questionnaire used was comprised of three questions on gender, race and ethnicity based on the US Census (2000) definitions. In addition, the research questions used the LSI by Felder and Soloman (1999) to categorize student learning styles. The learning style preferences on four dimensions (active-reflective, sensing-intuitive, visual-verbal, and sequential-global) are assessed by the instrument and discussed in this section. The findings are presented using both demographic and learning style data from the demographics questionnaire and the ILS.

Analysis of Research Question 1

Which learning styles are evidenced by minority college students as measured by the Felder-Solomon Learning Style Inventory? Since Research Question 1 is descriptive, there is no hypothesis for this question.

Research Question 1 was designed to ascertain if there is a particular learning style preference by minority students. The data presented is distributed between learning styles and race and ethnicity for each of the four dimensions in the ILS learning style categories.

The demographics questionnaire and the ILS provide information regarding the learning styles of the respondents. In the following section, the tables present the data separately for the four dimensions as it relates to both race and ethnicity.

Table 12 provides data gathered from the demographics questionnaire about minority groups, as well as White respondents with respect to the first group in the ILS (active–reflective learners). Minority groups refer to both Hispanics and Black-African American students. However, all the races in the demographics survey are shown for consistency, as well as comparison of learning styles. The predominant learning style was that of active learning. Fifty-seven percent of White students were active learners in comparison to 49% for Black-African American students and 58.8% for Hispanics. In contrast, Asian students predominantly preferred a reflective learning style (63.6%).

Table 12

Race-Ethnicity and Active-Reflective Learners

		ILSAR		Total
		Active	Reflective	
Race	White	43	32	75
	Black- African American	25	26	51
	Asian	4	7	11
	Native Hawaiian- Pacific Islander	0	1	1
	Other Race Alone	12	12	24
Total		84	78	162
Ethnicity	Hispanic	30	21	51
	Non-Hispanic	54	57	111
Total		84	78	162

Table 13 provides the data regarding the second group in the ILS (sensing and intuitive learners) with respect to minority groups. The majority of students (77.8%) in this group indicated a preference for a sensing learning style. Eighty percent of White students, 78% of Black-African American, and 82.3% of Hispanics preferred this style. Asians (72.7%) did as well.

Table 13

Minority Groups and Sensing-Intuitive Learners

		ILSSI		Total
		Sensing	Intuitive	
Race	White	60	15	75
	Black- African American	40	11	51
	Asian	8	3	11
	Native Hawaiian- Pacific Islander	0	1	1
	Other Race Alone	18	6	24
Total		126	36	162
Ethnicity	Hispanic	42	9	51
	Non-Hispanic	84	27	111
Total		126	36	162

Table 14 provides the data regarding the third group in the ILS (visual-verbal learners) with respect to minority groups. Visual learning was the predominant learning style for all groups. Whites (81.3%) preferred visual learning, 72.5% of Black-African American, 81.8% of Asian, and 82.4% of Hispanics did as well.

Table 14

Minority Groups and Visual-Verbal Learners

		ILSViVR		Total
		Visual	Verbal	
Race	White	61	14	75
	Black-African American	37	14	51
	Asian	9	2	11
	Native Hawaiian-Pacific Islander	0	1	1
	Other Race Alone	21	3	24
Total		128	34	162
Ethnicity	Hispanic	42	9	51
	Non-Hispanic	86	25	111
Total		128	34	162

The learning styles referring to sequential and global learners are presented in Table 15 with respect to minority groups. Sequential learning was the overall preferred learning style for all groups. Sixty-eight percent of Whites showed a preference for this style. Black-African American (76.5%), Asians (81.8%), and Hispanics (74.5%) also showed a preference for sequential learning.

Table 15

Minority Groups and Sequential-Global Learners

		ILSSeG		
		Sequential	Global	Total
Race	White	51	24	75
	Black- African American	39	12	51
	Asian	9	2	11
	Native Hawaiian-Pacific Islander	1	0	1
	Other Race Alone	19	5	24
Total		119	43	162
Ethnicity	Hispanic	38	13	51
	Non-Hispanic	81	30	111
Total		119	43	162

The frequency and percentage of learning styles from all respondents who took the ILS are presented in Table 16. Each group in the ILS is presented separately for each student who took the ILS survey.

Table 16

Frequency and Percentage of Learning Styles

	Frequency	Percent
Active	84	51.9
Reflective	78	48.1
Total	162	100.0
Sensing	126	77.8
Intuitive	36	22.2
Total	162	100.0
Visual	128	79.0
Verbal	34	21.0
Total	162	100.0
Sequential	119	73.5
Global	43	26.5
Total	162	100.0

Data Analysis and Relationship

The following section discusses research questions 2 through 4 in which relationships are made between learning styles, achievement of students as measured by grades, and race and ethnicity. For the next part of this chapter, the use of various statistical tests such as Crosstabs, Independent Measures Analysis of Variance (ANOVA), and chi square were conducted to test the hypotheses.

Analysis of Research Question 2

What is the relationship of preferred learning style and achievement as measured by grade obtained? The hypotheses relevant to this research question were:

Null Hypothesis 2: No relationship exists between preferred learning style and achievement as measured by grade obtained.

Alternative Hypothesis 2: A relationship exists between preferred learning style and achievement as measured by grade obtained.

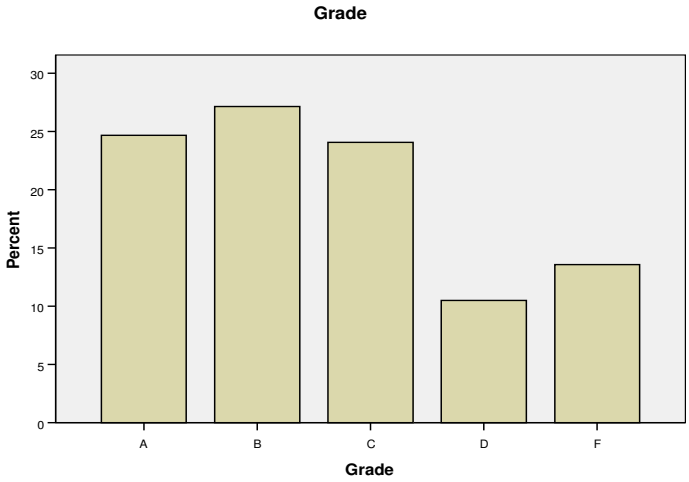

Figure 3. Grade distribution of respondents. Summary of the grade distribution of the respondents.

The grade distribution shows that the majority of students did well in the class, obtaining grades of A, B or C. In this study, achievement was defined as having passing grades of A, B or C. Overall, 25% of the students obtained an A, whereas 27% of the students obtained a B, and 24% a C.

Table 17 provides the grade distribution with respect to the four groups in the ILS. Active learning was preferred by 73.8% of students who succeeded in the course, while 78.2% preferred reflective learning. In the second group of learning styles, most students were sensing learners (126) with only 36 being intuitive. Seventy-seven percent Students who succeeded in the course preferred sensing as the learning style of choice, while 72% of students preferred intuitive learning.

Table 17

Grades and Learning Styles

		Grades					Total
		A	B	C	D	F	
ILSAR	Active	17	23	22	8	14	84
	Reflective	23	21	17	9	8	78
ILSSI	Sensing	33	35	29	10	19	126
	Intuitive	7	9	10	7	3	36
ILSViVR	Visual	34	36	27	12	19	128
	Verbal	6	8	12	5	3	34
ILSSeG	Sequential	29	32	28	12	18	119
	Global	11	12	11	5	4	43

Visual learners predominated in the third group of the ILS with 128 out of 162 respondents. Ninety-seven students who were visual learners earned a C or better. Twenty-six students selected verbal learning as their preferred learning modality. Out of

the students who preferred visual learning, 75.8% succeeded in the course whereby 76.5% were verbal.

The fourth group of the ILS shows that sequential learners predominated over global learners with 119 respondents. Eighty-nine students who were characterized as sequential learners received a C or better. As for sequential learners, 74.8% of respondents who successfully completed the course preferred this type of learning. Global learners constituted 79% of the students who passed the course.

An analysis of variance (ANOVA) was done to evaluate the mean differences between the dependent variable (grade) and the independent variables (learning styles). Analysis of Variance (ANOVA) is a statistical procedure comparing the amount of variance between groups in individual scores with the amount of variance within groups. Table 18 provides the results from the ANOVA test. The predictors for this test were the learning styles. The analysis of variance revealed that there was no significant difference, $F(4,157) = .919$, $p > .05$.

Table 18

ANOVA of Grades and Learning Styles

Model		Sum of Squares	*df*	Mean Square	*F*	*p* value
	Regression	6.508	4	1.627	0.919	0.455
	Residual	277.992	157	1.771		
	Total	284.500	161			

Based on the ANOVA, no relationship existed between preferred learning style and achievement as measured by grade obtained; therefore, failure to reject the null hypothesis occurred.

Analysis of Research Question 3

What is the relationship between a learning style and a minority group defined by the college's demographic questionnaire? The hypotheses relevant to this question are:

Null Hypothesis 3: No relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Alternative Hypothesis 3: A relationship exists between a learning style and a minority group defined by the demographic questionnaire.

In order to test the hypotheses for this question, the following tests were conducted: chi square and Crosstabs. Both race and ethnicity were used to correlate the learning styles in these analyses. Crosstabs analysis was used for Table 19 regarding minority groups and learning styles.

Table 19

Race-Ethnicity and Learning Styles Crosstabs

Learning Styles		ILSAR		ILSSI		ILSViVR		ILSSeG	
		A	R	S	I	Vi	VR	Se	G
Race	White	43	32	60	15	61	14	51	24
	Black-African American	25	26	40	11	37	14	39	12
	Asian	4	7	8	3	9	2	9	2
	Native Hawaiian-Pacific Islander	0	1	0	1	0	1	1	0
	Other Race	12	12	18	6	21	3	19	5
Ethnicity	Hispanic	30	21	42	9	42	9	38	13
	Non-Hispanic	54	57	84	27	86	25	81	30

Note. A-Active, R-Reflective, S-Sensing, I-Intuitive, V-Visual, VR-Verbal, Se-Sequential, G-Global

Table 19 shows the headcount number of minority students (Black-African American and Hispanics, which are the focus of this study, categorized by the preferred learning styles. The data shows that Black-African American students almost equally prefer active versus reflective learning (49% and 51%, respectively). They prefer sensing (78%), visual (72.5%) and sequential (76.5%) learning.

Hispanics showed a slight preference for active (58.8%) learning. Hispanics, like African-Americans, prefer sensing (82.4%), visual (82.4%) and sequential (74.5%) learning. Asians preferred reflective (63.6%) to active learning. They also preferred sensing (72.7%), visual (81.8%) and sequential (81.8%) learning. Only one Native Hawaiian responded to the survey. The results for this respondent were that of reflective, intuitive, verbal and sequential. Whites preferred active (57.3%), sensing (80%), visual (81.3%), and sequential (68%) learning.

A *chi-square* test for goodness of fit was done and is shown in Table 20.

Table 20

Chi-square (χ^2) Test for Race-Ethnicity and Learning Styles

Learning Styles		ILSAR		ILSSI		ILSViVR		ILSSeG	
		χ^2	*p*	χ^2	*p*	χ^2	*p*	χ^2	*p*
Race	White	1.613	.204	27.000*	.000	29.453*	.000	9.720*	.002
	Black-African American	0.020	.889	16.490*	.000	10.373*	.001	14.294*	.000
	Asian	0.818	.366	2.273	.132	4.455*	.035	4.455*	.035
	Other Race	0.000	1.000	6.000*	.014	13.5000*	.000	8.167*	.004
Ethnicity	Hispanic	1.588	.208	21.353*	.000	21.353*	.000	12.255*	.000
	Non-Hispanic	0.081	.776	29.270*	.000	33.523*	.000	23.432*	.000

Note. df = 1 for all categories, asterisk (*) represents reject H_0, $p < .05$

Black-African American and Hispanic students showed a significant preference for sensing, visual and sequential learning thus rejecting the null hypothesis for these learning style categories. Failure to reject the null hypothesis occurred for the first learning style category (active-reflective learning) for these students. Asian students were found to have a significant preference for visual and sequential learning, thus rejecting the null hypothesis for these two categories. However, no significant preference was found for active-reflective and sensitive-intuitive learning, thus, failing to reject the null hypothesis for these two categories. White students were found to have significant learning style preferences the same to the minority students (Black-African American and Hispanics). The chi-square test was not performed for Asian students due to only one respondent in this category.

Analysis of Research Question 4

What is the relationship between achievement and minority group defined by the college's demographic questionnaire? The hypotheses relevant to the research questions are:

Null Hypothesis 4: No relationship exists between achievement and minority group defined by the college's demographic questionnaire.

Alternative Hypothesis 4: A relationship exists between achievement and minority group defined by the college's demographic questionnaire.

The data was analyzed for this question using statistical tests as presented in Research Questions 2.

Table 21 presents data on student achievement and the demographics including minority groups (Hispanics and Black-African Americans). Student achievement was measured by passing grades of C or better. A total of 123 students passed the course out of the 162 (75.9%). The data showed that fewer Black-African American (62.7%) students have passing grades than Whites (82.7%). Hispanics (76.5%) taking biology passed with a C or better. Asians on the other hand have a 90.9% achievement rate. Black-African Americans had a 20% lower rate of achievement than Whites and a 13.8% lower rate than Hispanics. Hispanics also had a 6.2% lower rate than Whites. On the other hand, Asians had a higher rate than Whites (8.2%).

Table 21

Achievement and Demographics

		Race						Ethnicity		
		White	Black-African American	Asian	Native Hawaiian-Pacific Islander	Other Race Alone	Total	Hispanic	Non-Hispanic	Total
Grade	A	24	8	5	0	3	40	12	28	40
	B	17	14	2	0	11	44	14	30	44
	C	21	10	3	1	4	39	13	26	39
	D	6	8	1	0	2	17	5	12	17
	F	7	11	0	0	4	22	7	15	22
Total		75	51	11	1	24	162	51	111	162

Table 22 provides the ANOVA results for grades and race-ethnicity.

Table 22

ANOVA of Grades and Race-Ethnicity

		Sum of Squares	*df*	Mean Square	*F*	*p* value
Race	Between Groups	17.014	4	4.253	1.470	.214
	Within Groups	454.424	157	2.894		
	Total	471.438	161			
Ethnicity	Between Groups	0.030	4	0.008	.034	.998
	Within Groups	34.914	157	0.222		
	Total	34.944	161			

ANOVA was conducted to analyze the data for Research Question 4. The result of the statistical analysis did not yield any significant relationship between learning styles and minority groups.

Summary

Throughout this chapter, the data was presented in tables and charts to augment the presentation of the results. The demographics of the college and those of the biology students were summarized as well as those of the respondents of the demographics questionnaire. The sample was selected from randomly chosen biology classes and the students asked to participate on a volunteer basis. A total of 162 surveys were completed by respondents accounting for a 73% return. Each of the research questions were addressed using statistical analyses with the null hypotheses for consideration. Statistical information was obtained on three demographics categories: gender, race and ethnicity. Gender was not included as an integral aspect of the research questions, however, data for the respondents were provided. There were four research questions tested.

The participants were volunteers from a randomly selected sample of biology courses and may be a threat to the internal validity of this study. The students who participated in this study may not necessarily represent the total sample size and/or population of biology students. The participants in the demographics survey do show differences from those of the overall college population and for the overall biology students. There were fewer Whites (46.3%) who participated in the study than those enrolled in biology (61.6%) or in the college population (60.6%). Black-African Americans constituted 31.5% of the respondents compared to those enrolled in biology (23%) and in the college population (28.5%). The percentage of Hispanic students who participated was 31.5% which is not significantly different from that of the college or enrolled students in biology.

Further explanation of the findings is presented in Chapter 5. Discussion of the findings of this study and how it contributes to the understanding of minorities and its relation to student achievement is provided. Implications for educational social reform and recommendations for teaching and future studies are discussed.

CHAPTER FIVE:

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

A primary goal of this chapter is to summarize the results and discuss the implications and significant factors that may aid in the educational achievement of minority groups in biology courses. This was based on previous information regarding the lack of minority groups entering science careers.

Beginning in elementary to graduate school, minority students are underrepresented in science and math. Clark (1999), stated that "lack of preparation in science among underrepresented minority groups in the early elementary grades undermines enrollment and achievement in secondary level school programs, and ultimately, in college and career choices later in life" (para. 1). Due to low achievement, especially in science classes, minorities become embedded in a sense of failure; therefore, they choose careers other than science. Proper preparation in the sciences can enable students to prepare themselves for careers in a technologically driven society (Clark, 1996).

In addition, White majority educators in sciences and other fields teach from their own perspectives. How teachers view others, and interpret experiences, relationships and ideas are based on race and culture (Kendall, 2006). Ethnocentric views may be used by teachers in multicultural schools, without considering the cultural population of their students. Access to good schools with resources and to teachers who are qualified in science and mathematics are common problems that minority students encounter (Oakes,

Ormseth, Bell & Camp, 1990). Opportunities for minority groups and achievement in science and mathematics may be decreased.

The main concern in the scientific community exists regarding not only future retiring scientists in the workforce, but that of the low minority representation in that area, as well as, in higher education. The U.S. Census Bureau Report (2003) indicated that Blacks, Hispanics, and Asians are the fastest growing minority groups. These groups, therefore, could potentially fill the predicted gap that is predicted in the scientific community and in the educational workforce.

Educators have observed that some students prefer certain methods of learning more than others (Diaz & Cartnal, 1999) and, in particular, that different minority groups have varying learning style preferences. Due to the rising numbers of minorities nationally, diversity is posing greater challenges on instruction indicating that this needs to be addressed (Anderson and Adams, 1992). Students have varied learning styles, which are characterized strengths and preferences in the ways that they process information and learn.

Hodges (1988) stated that it was important to know the learning styles of students in order to assist them to succeed. If preferred learning styles were known for various minority groups, then teaching techniques could be applied to these students, thereby improving achievement.

This dissertation offers educators insight into understanding the importance of how student learning styles relate to achievement in minority groups. Since underrepresented groups in the scientific fields were few, including those in the school system majoring in the sciences, the next step became the understanding of the reasons

why these groups are not entering these fields. Minority students are expected to adapt to the predominant White culture and faculty and staff (Garcia, 1999; Helms, 2003). Cultural diversity is not embraced when faculty and staff look to change the student. However, cultural diversity is embraced when faculty look at the students' preferences and they make modifications in their teaching for the sake of the student. Cultural differences should be viewed as an opportunity to improve learning and not as one to make the student adapt to the dominant White culture.

Various learning style models provide foundational information for instruction and curriculum design. Since students learn in different ways, teaching methods also should not only vary but should take into consideration these differences. While some instructors lecture and teach using a variety of activities, instruction may not consciously include understanding the student population they teach, particularly, if it is minority. If a mismatch occurs in teaching style and learning style, the student may not only do poorly, but withdraw from the class. If students fail to achieve in science courses, it most likely deters students for continuing on a science-career path and they seek alternative careers. Failure to achieve in courses begets students to follow alternate courses in which they feel a sense of accomplishment. Proper preparation in the sciences can enable students to prepare themselves for careers in a technologically driven society (Clark, 1996). This applies to all students but in particular, minority groups who do not usually enter these fields. The cultural background of students in college must be understood by educators in order to understand their particular learning style. Understanding that students from different cultures may have different learning styles is the first step to increasing student

enrollment in the science courses and careers, as well as, increase their achievement in these courses.

The Study

Since minority adult students have less academic achievement than White students, understanding learning styles is needed. Comprehension of how students learn, the learning style characteristics, and their preferences can aid teaching practices (Felder, 1998). Learning styles are a collection of multiple modalities that determine how an individual perceives, processes and understands information. Learning styles are considered multiple modalities that determine how an individual perceives, processes and understands information. These are a major factor influencing a student's educational performance (Felder, 1998; Torres & Cano, 1994).

This study used the Felder-Silverman (1988) model of learning styles. The Felder-Silverman model shows that students can be very different in how they prefer to learn. Originally, the model emphasized four different but dichotomous methods of learning: sensing-intuitive, visual-verbal, active-reflective, and sequential-global. These are the individual's preferred learning style. What these refer to are (a) the sensory method by which information is received, (b) the modality by which information is received, (c) the process why which information is received, and (d) the order in which the information is received. In order to further understand the five main categories, an explanation of the areas is required. Students under the Felder model are classified into the following categories:

1. sensing learners (concrete, practical) or intuitive learners (innovative, conceptual),

2. visual learners (pictures, diagrams preferred) or verbal learners (written and spoken information preferred),

3. active learners (prefer to do things) or reflective learners (prefer to think things through), and

4. sequential learners (prefer to be orderly, linear) or global learners (holistic, system thinkers).

These methods of learning were incorporated by Felder and Soloman (1996) into an Inventory of Learning Styles (ILS) survey. The study design used the Felder-Soloman survey (1996), which was developed using the Felder-Silverman dimensions of learning styles, for ascertaining student learning styles. The ILS classifies students in the Felder-Silverman dimensions previously discussed. As a foundation to this study design, the Felder-Soloman ILS was the research tool used with the respondents for the purpose of this study; to examine the relationship between learning style preferences and achievement by adult minority students in a multicultural college. Understanding how college students learn (Anderson & Adams, 1992) and that students have different cognitive skills and learning styles at the college level needed to be better understood. The first step in this process was to ascertain how students learn and, particularly, minority students, who usually have lower achievement rates than Whites in science classes (National Science Foundation STEM Workshop Report, 2005).

The study was conducted using a random sample of biology classes at a multicultural college. A demographic questionnaire and the ILS were provided to the

students by the course instructor. The results of these were given to the researcher along with the final student grade at the end of the course. Respondents remained anonymous to the researcher. Various studies verified the reliability of the ILS instrument (Felder & Spurlin, 2005; Litzinger, Lee, Wise, & Felder, 2005; Tate, 2003; Zywno, 2003). Analytical tabulations of the statistical data and the results were provided in Chapter 4. The next section of this chapter discusses the results of the statistical data analysis.

Interpretation of the Findings

For the purpose of this study, 162 students completed both the demographic questionnaire and the ILS. Of these, 51 respondents were Black-African American (31.5%), 11 were Asian (6.8%), 75 were White (46.3%), and 1 was Native Hawaiian-Pacific Islander (.6%). In addition, 51 respondents were Hispanic (31.5%) with 111 students (68.5%) responding as non-Hispanics.

In comparison to the total college population of Black-African American students (28.5%), there is a higher percentage of these students who enroll in biology courses (31.5%), which is 3% more students who enroll. Hispanics have a similar enrollment showing that 31.5% enrolled in these courses in comparison to the total college Hispanic population of 29.8%, indicating 1.7% more enrolled. A slightly higher percentage was also seen in Asians (6.8%) with respect to the college population (6%) for a .8% higher rate. Whites on the other hand had fewer students enrolling in Biology (46.3%) than the total college population (60.6%), having 14.3% fewer enrolled. This could be due to Whites entering medical programs at the college, such as Nursing and Allied Health, which rely heavily on anatomy and physiology courses as well as microbiology instead of

biology. In most community colleges, many students enter medical programs as a gateway to medical schools or to careers in these fields. In addition, many students enroll in business programs, which traditionally have very large enrollments. In addition, this study did not incorporate online biology classes, and these may have higher Whites enrolling in these courses than minority groups. This may be an area for future study.

Respondents included 34 males (21%) and 128 females (79%) who completed the survey. Gender was not a factor considered in the study, although it is interesting to note that more females enrolled in biology courses than males.

This study posed four research questions to determine whether there was a relationship between learning style and achievement in minority students in biology courses. Biology was used as the course of choice because it is a gateway course for students entering careers in science.

Research Question 1

Which learning styles are evidenced by minority college students as measured by the Felder-Solomon Learning Style Inventory?

The major findings of this question were derived from both the demographics questionnaire and the ILS. This research question was descriptive; therefore, it did not have hypotheses. For the four dimensions of learning styles: active-reflective, sensing-intuitive, visual-verbal, and sequential-global, data was obtained and presented in Tables 12 through 16.

The predominant learning style was active in the first modality for all races and ethnicities. The majority of students (77.8%) preferred a sensing learning style. Visual and sequential learning were also preferred learning styles for all groups.

Students preferred sensing over intuitive, visual over verbal, and sequential over global. Black-African American students did not prefer active over reflective learning styles as demonstrated from the ILS. The number differential was almost half for each choice of active versus reflective for race and ethnicity. All students indicated the same preferences, however, and what is implicated by these results is that as demonstrated with the demographic data that minority students enroll in these classes at a higher rate than Whites. Since these students demonstrate a preference in certain learning styles over others, this information can be used to infer teaching techniques that may enhance achievement. Achievement in the biology classes is discussed in Research Questions 2 through 4.

Research Question 2

What is the relationship of preferred learning style and achievement as measured by grade obtained?

The hypotheses for this question were as follows:

Null Hypothesis 2: No relationship exists between preferred learning style and achievement as measured by grade obtained.

Alternative Hypothesis 2: A relationship exists between preferred learning style and achievement as measured by grade obtained.

In this study, achievement was defined as obtaining a grade of A, B or C. Overall, most students passed the biology course with 25% receiving an A, 27% a B, and 24% a C. From this information, it can be seen that 24% of the students failed the course. Table 17 provided the data for this research question.

No relationship was found in student achievement for any of the four dimensions in learning styles. ANOVA ($F(4,157) = .919$, $p > .05$) analysis did not show significant difference in learning style preference and achievement. Failure to reject the null hypothesis occurred. For example, active learning (73.8%) was selected versus reflective (78.2%) for students who succeeded in the course. In addition, sensing learners (70%) versus intuitive learners (72%) of students selected passed the course. For the third dimension, visual learners (75.8%) and students who selected verbal learning (76.5%) also passed the course. Sequential (74.8%) and global learners (79%) of students who selected these facets of the dimension also passed.

Of importance in this analysis is that learning style and achievement was not a factor. Therefore, overall learning styles are not a facet to achievement. However, race and ethnicity were not accounted for in this question; only overall learning style preference and achievement were.

Research Question 3

What is the relationship between a learning style and a minority group defined by the college's demographic questionnaire?

The hypotheses relevant to this question are:

Null Hypothesis 3: No relationship exists between a learning style and a minority group defined by the demographic questionnaire.

Alternative Hypothesis 3: A relationship exists between a learning style and a minority group defined by the demographic questionnaire.

This question ascertained if a relationship existed between a minority group and a learning style. The data presented in Table 19 demonstrated that Black-African American students almost equally preferred active versus reflective learning (49% and 51%), respectively. No significant relationship was found for this dimension of learning style using the chi-square test with a $p < .05$. However, using the same statistical test, a significant relationship was found by this minority group for sensing, visual and sequential learning styles. The same conclusions were found for Hispanic students showing that sensing (82.4%), visual (82.4%), and sequential (74.5%) learning styles were preferred. Active learning was the same for Hispanics (58.8%) as for Black-African Americans with no significant relationship seen. Asians had a significant preference in the visual (81.8%) and sequential (81.8%) learning style dimensions. Though they had a slight preference for reflective learning over active and sensing over intuitive, it was not found to be a significant preference with the chi-square test. The other students in the study preferred active over reflective, opposite to the Asian students.

Failure to reject the null hypothesis occurred for African-American, Hispanics and Asian students for the first dimension in learning style. They did not have any significant preference of active over reflective learning. However, rejection of the null hypothesis did occur for African-American, and Hispanics for sensing, visual, and sequential learning styles using chi-square test. Whites showed a significant preference in

the same learning style preferences as the minority students. Failure to reject the null hypothesis occurred for active-reflective learning styles. Rejection of the null hypothesis did occur for sensing-intuitive and visual-verbal, and sequential-global dimensions of learning.

Therefore, minority groups (Black-African American and Hispanics) including Whites showed a significant preference for sensing, visual and sequential learning styles. This particular research question demonstrated that there are significant preferences amongst minority groups, as well as, White students, and their preference for various learning styles. Implications for understanding this significant difference will be discussed further in this chapter.

Research Question 4

What is the relationship between achievement and minority group defined by the college's demographic questionnaire?

The hypotheses relevant to the research questions are:

Null Hypothesis 4: No relationship exists between achievement and minority group defined by the college's demographic questionnaire.

Alternative Hypothesis 4: A relationship exists between achievement and minority group defined by the college's demographic questionnaire.

As with Research Question 2, achievement was measured by a passing grade of C or better. Table 21 provided the data showing that fewer Black-African American students (62.7%) had passing grades as compared to Hispanics (76.5%), Asians (90.9%), and Whites (82.7%). From analysis of this research question, it can be seen that the

highest achievers were Asians, followed by Whites and then Hispanics, having Black-African Americans with the lowest passing percentage. Black-African Americans had a 20% lower passing rate compared to Whites. Hispanics had a 13.8% lower rate compared to Whites, with Asians surpassing Whites by 8.2%.

No significant relationship was found between the variables of race-ethnicity and grades using ANOVA analysis with the alpha level of .05, therefore, rejection of the null hypothesis occurred between achievement and minority groups.

Conclusion of the Analysis of the Study

A total of 162 surveys were completed and grades provided for each of the respondents by the course instructor. Each research question was addressed using statistical analyses with the null hypothesis for consideration and discussed in each of the sections pertaining to the research questions above in this chapter.

The results from this study showed that the predominant learning style preferred for minority and White students except Asians, was active learning over reflective learning, which was found not to be significant using statistical analysis. However, minority and White students did have significant preferences in sensing, visual and sequential learning. On the other hand, analysis showed no relationship between learning style and achievement; therefore, overall learning styles are not a predictor of achievement. Minority groups along with Whites, showed a significant preference for sensing and visual and sequential learning styles. Lastly, the minority groups that had the lowest passing percentage were Black-African American students, followed by Hispanics and then Whites, with Asians having the highest achievement. However, the number of

Asian respondents was low and may not reflect the accurate population of Asians at the college.

Applications of Learning Styles

The predominant learning style found for all students was active learning, though a good number of students also chose reflective learning. Instructors using methods that promote discussion, application or having students working on groups explaining information to each other can promote active learning in their environment. Reflective learners prefer to think about the situation before acting on it. Group interactions and activities promoting discussion enhance both active and reflective learning, for both types of learners have a chance to employ their preferred style. Since reflective learners prefer working alone, a combination of group and solo assignments in class enhance both styles of learning.

In addition, all groups showed a significant preference for sensing and visual learning. Sensing learners tend to like learning facts, solving problems using methods that have been previously employed, and are good with hands-on work. Intuitive learners on the other hand enjoy discovering relationships and possibilities, innovative situations, and even mathematical concepts. Since most students showed a preference for sensing learning in this study, instructors could employ methods that would promote this learning style such as case studies, projects and hands-on work in their instruction. For students who chose intuitive learning as their method of choice, class activities may employ their use in group activities in which they could be the innovators, the planners, and the project coordinators, while the sensing students could be more the factual and hands-on activity doers. Both styles could be accommodated if the learning preferences were known.

However, in this study, since sensing was a significantly preferred, the majority of classroom activities could be employed to enhance this type of learning method.

For visual learners, visual aids, diagrams, demonstrations, and videos can enhance learning. Power points with additional embedded visual pictures, animations, and videos could help students learn using this method. Some students chose verbal learning as their preferred style, though few respectively to visual learning. Verbal learners learn through listening, though they also benefit from both written and spoken explanations. In college, most lectures are still primarily verbal with lectures read or explained. Writing on whiteboards or chalkboards, handouts, and textbooks are still the predominant tools used in college classrooms. Most students are visual learners and unfortunately, techniques that cater to verbal learning are not addressing the visual learners. They are not getting as much as they would if visual techniques were used in class. If both visual and verbal techniques were employed in class, the processing of information might be maximized.

The study found that there was a significant preference for sequential learning by all groups. Whites and minorities displayed a significant preference for sequential over global learning. Sequential learning takes place in linear steps with each step following a logical sequence from a previous one. Global learners absorb information and unlike sequential learners, understand all of a sudden without having to follow a series of steps to get to the result or conclusion. Global learners will comprehend all of a sudden without being able to explain how they got to their result (Felder, 1999). Since sequential learning was a significant preference for minority students, instructors using a sequential and methodological approach to teaching could possibly enhance learning and achievement in class as well as individually. It is noteworthy to state that in biology classes, massive

amounts of information are presented to students that characterize biological concepts without necessarily making connections. If instructors planned a sequential method using tools that may be visual and assignments that promote active participation in a logical sequential manner so that students learn in small steps leading to the grand conclusion, more students, including minorities may succeed.

All classes have a variety of students with different learning styles. However, knowing the learning preferences of the students in class could assist instructors in planning what activities, tools, and methodologies should be used to teach the subjects in their course. In this study, minorities and Whites were found to have a significant preference for sensing, visual and sequential learning. However, minorities were also found to have a lower achievement rate in biology classes than Whites and Asians. Though Whites and Asians also preferred visual and sequential learning, it is important to note that the low achievement of the other minority groups in comparison may also be accounted for by the barriers or obstacles that minority students may have encountered prior to their experience at the college. As mentioned previously in chapter two, the main barriers to minority achievement in the sciences are, as related to this study, categorized into five main areas: (a) judgments about ability, (b) access to science and math programs, (c) access to qualified teachers in science and math (Clark, 1996), (d) access to curricula and resources (NCTAF, 2003; NSF, 1996), and (e) opportunities in the classroom. Each of these barriers could minimize participation by minority groups in science and math courses, programs, and careers. In addition, these barriers could affect how students enter college biology or other science classes, in other words, how prepared they are to succeed in college biology. Being under-prepared may pre-determine student

achievement in difficult science courses. Though Black-African Americans, Hispanics, and White students preferred visual, sensing and sequential learning, Whites had a higher level of achievement than the other groups. Under-preparedness may be a reason why minorities did not achieve as well as White students.

An important analysis that can be seen from the data provided in this study is that although more Black-African American and Hispanic students enrolled in biology than the same groups seen in the total college population, fewer of these minority students successfully completed these classes than Whites and Asians. On the other hand, fewer Whites and Asians enrolled compared to the total college population and these groups had a higher achievement rate. When comparing learning styles to achievement, Black-African Americans, Hispanics and White students had a preference for the same learning styles. Since the dimensions were the same, learning style preferences amongst the groups was not a factor to achievement. Other factors are indicated as playing a role to the differences in student achievement. The differences may be the preparedness of students entering sciences and it also may indicate the teaching styles of the instructors in these courses. Asians had high achievement rates in comparison to the other minority groups. This, however, may not be representative of the student body due to the low number who responded not being representative of the total Asian population at the college. It may also be accounted for by the possibility that Asians may be better prepared as they enter college than the other minority groups.

Projections from the Bureau of the Census Current Population Survey Report (1999–2001), show that minorities (Asians-Pacific Islanders, Blacks, Hispanics, and American Indians-Alaskan Natives) are expected to be more than half (52%) of the

resident college-age (18–24 years old) population of the United States by 2050, up from 34% in 1999. The greatest projected growth is in Hispanics and Asians, reflecting immigration trends with little growth for college-age African-Americans. Ogden, Ogden and Schau (2004), report that the U.S. Census Bureau (2003) has Blacks, Hispanics, and Asians as the fastest growing minority groups. In addition, enrollment figures show that underrepresented minorities in Higher Education Institutions comprise 10.4% of the total student population of college students, with only 7.5% of these students earning doctorate degrees in any field (NSFS&E Indicators, 2006). This report provides data that these groups are either not enrolling as much as they could in college programs, or they are withdrawing from their course of studies. Although these statistics are for overall fields, the proportion of students in the sciences is, therefore, even less. Concern in the scientific community exists regarding not only future retiring scientists in the workforce, but that of the low minority representation in that area including higher education. Clark (1999, para. 2) stated that "lack of preparation in science among underrepresented minority groups in the early elementary grades undermines enrollment and achievement in secondary-level school programs, and ultimately, in college and career choices later in life."

Due to low achievement in science classes, minorities become embedded in a sense of failure in this subject area; therefore, they choose careers other than science. Minorities, thereby, are depriving themselves of the potential of careers in sciences. Proper preparation in the sciences can enable students to prepare themselves for careers in a technologically driven society (Clark, 1996). This applies to all students but in particular, minority groups who do not usually enter these fields.

The potential crisis anticipated in scientist shortfall can be addressed by acknowledging that minority groups should be encouraged to enter scientific fields, including teaching in the sciences. By reaching out to minorities the educational system may be able to fill the gap in the areas which will be affected in the next decade. If the pattern of demographic growth continues, in about 20-30 years, the number of children in elementary schools will be about equally split between Whites and minority groups. (US CENSUS, 1999-2001). This has tremendous implications for social change and the effects on the minority population since opening the door to opportunities in science careers in research, education and technology has the capacity to enhance the socioeconomic status of these groups. In addition, the opportunities afforded through careers in these areas can begin a new era of how minorities view their potential, how children may aspire to careers that were not part of their cultural esteem, and how they view their overall self-esteem and self confidence in education.

In addition, educational reform is implicated since an educationally responsive community should be involved in using data to increase student achievement. Faculty who understand that a minority student's preferred learning style can be used to implement teaching strategies more conducive for that student's learning can help students to achieve. Recommendations for faculty entail providing the opportunity for students to do the ILS, therefore, learning the learning styles of the students in the beginning of the semester. Faculty who know the preferred learning styles of the students can implement teaching strategies that are conducive for higher achievement. In addition to faculty learning how to teach minorities, advisors can help students match their learning style to faculty teaching styles. This study provided a basis for faculty to form

teaching/learning communities and provide information to students about teaching and learning style preferences. This can also be used to form new Advisor paradigms and how they assist students enroll in classes by aligning students to instructors with matching teaching styles. Using research-based data this can lead to educational reform through learning communities that allow faculty to reflect on their teaching and student learning (McLaughlin & Talbert, 2001).

American culture is very independent and does not necessarily value overt connectedness among individuals (Markus & Kitayama, 1991). However, minority groups, such as Hispanics, and Black-African American groups, value interdependence, whereas White culture is very independent and does not necessarily value overt connectedness among individuals (Markus & Kitayama, 1991). Faculty having knowledge of this information may assist in the creation and delivery of instructional activities in classrooms encompassing the culture of the minority groups being taught. Collaborative activities, involving group interaction presented in a sequential way embraces the minority concepts of interdependence and construal of self and others.

Students have different learning styles and in the educational forum, faculty should be helping students build skills not only in their educational field of study, but in their preferred learning method. This is important because, as previously stated matching student learning styles and teaching styles can increase student achievement. Teachers also have different teaching styles. Mismatches may occur between student learning styles and teaching styles. When this happens, students may not do well in class, and achievement decreases. The matching of student learning styles to teacher teaching styles may affect student achievement. Students who enroll in classes that are taught

incorporating methods conducive to that student's learning style may enhance achievement, thus retention and graduation. Data from previous studies has shown that minorities do not succeed in science fields; therefore, the study was of utmost importance, especially, knowing the potential scientific shortage and the underrepresentation of minorities in scientific careers. Studying the preferred learning styles of the minority students and the implications for faculty teaching courses to know which styles may be better suited for the students' learning modalities, could result in better achievement in science courses and science careers for these students.

The recommendations made from this study could revolutionize teaching for college instructors since knowing how students best learn, faculty could incorporate teaching strategies for the minority group being taught. This is a unique area in adult education that could implicate social and educational changes. If college instructors learned in the beginning of the term what the students preferred learning styles were, instruction could be modified to incorporate methods that are conducive to these modalities of learning. Though all classes will have students with many different learning styles, knowing the predominant learning style preferences could be beneficial. Instructional methods should incorporate a hodgepodge of multiple techniques for all students, but should emphasize the styles that most students learn best in. The literature has published very little in this area for the adult minority groups. This study can open a new era in educational research.

The proposed recommendations can lead instructors to implement more appropriate learning and teaching techniques for students. Due to the aforementioned, future decreases in the scientific community and the usually low number of minorities

that enter scientific careers, this study can significantly begin the process of changing how educators teach minority students, achievement in the sciences, perception of science courses, and the careers these students ultimately choose.

Recommendations for Future Research

The purpose of this study was to examine the relationship between learning style preferences and science achievement (grades) by adult minority students in a multicultural college. The specific populations under exploration were: Hispanics, Blacks, and other minorities. The intention was that this study would incite additional research in other science courses and nonscience courses, to address learning styles preferred by minority groups, as well as by all students.

Research in the field lacks studies correlating achievement to learning styles. This study found that there was no significant relationship between learning style and achievement. However, this study should be duplicated in other institutions of higher learning where large populations of minorities are found. In addition, though biology continues to be a gateway course into science careers including teaching, other science classes should be looked at. Few minorities enter chemistry, physics, and math careers. Gateway courses in these areas can be studied correlating student achievement and learning styles in order to ascertain if improvements in achievement could be implicated.

In addition, understanding how teaching tools can be adapted to the curriculum to maximize learning and achievement should be researched. Student preparedness for science courses should also be research in order to assess the role that underpreparedness may affect achievement in college science courses. This study did not study teaching

styles by the instructors. Future studies should duplicate this study and also include the teaching styles of the instructors. Since there were multiple instructors, ascertaining the teaching styles was beyond the scope of this study. Future studies may focus on teaching styles and relationship to student achievement. In addition, additional research could include cultural studies and their influence on learning styles, and which teaching and learning methods could be implemented to improve learning in different subject areas, especially chemistry, physics and math which are areas that are important in science careers. This study paved the way for innovative thinking in teaching minorities in the sciences for the purpose of increasing student achievement in this biology and other potential subjects.

The results of this study should be compared with similar studies, or duplicated in the future to determine if this instrument is the appropriate instrument to determine how education in biology or other science courses for minority students should be addressed. Due to the limitations of the research conducted in these areas, it is imperative that in order to increase achievement in minorities in science careers that research into this area should be encouraged and conducted. It is imperative for the future that minority students should be educated in such a way as to maximize their chances of entering science careers.

Conclusion

Performance disparities continue to increase between minority groups, usually underrepresented in the sciences, and the White majority students. Disparities are seen as early as kindergarten and increase as school age increases. As discussed in this chapter,

achievement in courses and programs is lower in minority students, especially Black-African American and Hispanics from those of Whites. The results from this study revealed that minority groups have learning style preferences. Implications incorporate that if pedagogy and teaching strategies were implemented for students, this could result in increased performance and achievement. Given the science career shortages, students from minority groups could be encouraged to succeed in science classes by using learning style information for the benefit of teaching strategy implementation. Thus, this study attempted to add to the body of knowledge in studying the relationship between learning style preference and student achievement in minority groups. Given the science professional shortage and low achievement by minority groups in this area, the study significantly added to the body of information that could be used to increase minority achievement in science classes. The ultimate intention is to promote more minorities to choose scientific or science-related careers.

Due to the aforementioned future projected decrease in the scientific community, and the usually low number of minorities that enter scientific careers, this study significantly began the process of changing how educators teach minority students, how they could be helped to achieve in the sciences, how they could perceive their achievement science courses, and the careers they ultimately could choose. In addition, a main intention of this study is that it leads to additional research in learning styles of minorities, as well as, of all students, in other science courses and nonscience courses.

REFERENCES

American Association for Employment in Education (AAEE). (2003). *2002 Educator supply and demand in the United States.* Columbus, OH: Author.

Anderson, J.A., & Adams, M. (1992). *Acknowledging the learning styles of diverse student populations: Implications for instructional design*. In L. L. Border & N. Van Note Chism, *New directions for teaching and learning*. (pp. 18-33). San Francisco: Jossey-Bass Publishers

Anguiano, R. P. V. & Harrison, S. M., (2002). Teaching cultural diversity to college students majoring in helping professions: The use of an eco-strength perspective. Copyright 2002 Project Innovation (Alabama). *College Student Journal*.

Banks, J. A. (2003). *Teaching strategies for ethnic studies* (7th ed.). Boston: Allyn and Bacon.

Banks, J.A. (2006) *Cultural diversity and education: Foundations, curriculum, and teaching* (5th ed.). Boston: Pearson Publications.

Banks, J. A., & Gay, G. (1978). Ethnicity in contemporary American society: Towards the development of a typology. *Ethnicity, 5*, 238-251. (ERIC Document Reproduction Service No. ED121641)

Barley, Z., Lauer, P. A., Arens, S. A., Apthorp, H. S., Englert, K. S. Snow, D., & Motoko, A. (2002). *Helping at-risk student meet standards: A synthesis of evidence-based classroom practices.* Aurora, CO: Mid-Continent Research for Education and Learning.

Baumgartner, L. (2001). Four adult development theories and their implications for practice. *National Center for the Study of Adult Learning and Literacy Publications. 5*(B).

Breen, N., & Kessler, L. (1994). Changes in the use of screening mammography: Evidence from the 1987 and 1990 National Health Interview Surveys. *American Journal of Public Health*, *84*(1): 62-67.

Bridge, R., Judd, C., Moodck, P. (1979). *The determinants of educational outcomes: The impact of families, peers, teachers, and schools*. Cambridge, MA: Ballinger Publishing.

Broward Community College SAS 2008 Report. Table 2. Retrieved from http://www.broward.edu/faculty-staff/rp/cwethnic.pdf

Bruner, J., (1987). *Actual minds, possible worlds.* Cambridge, MA: Harvard University Press.

Bruner, J., (1990). *Acts of meaning*. Cambridge, MA: Harvard University Press.

Bruner, J.V., (1996). *The culture of education.* MS: Harvard Univ. Press

Bush, W.S. (2003). *Understanding mathematics and culture in rural contexts.* ERIC Digest. (ERIC Document Reproduction Service No. ED482729). Retrieved from http://www.ericdigests.org/2004-3/rural.html

Caine, R., & Caine, G. (1994). *Making connections: Teaching and the human brain*. New York: Addison Wesley.

Cano, J. (1999). The relationship between learing style, academic major, and academic performance of college students. *Journal of Agricultural Education*. *40*(1), 30-37.

Cano, J., & Garton, B.L. (1994). The relationship between agriculture preservice teachers' learning styles and performance in a methods of teaching agriculture course. *Journal of Agricultural Education*. *35*(2), 6-10.

Clark, J. V. (1996). *Redirecting science education: Reform for a culturally diverse classroom.* Thousand Oaks, CA: Corwin Press.

Clark, J. V. (1999). *Minorities in science and math.* ERIC Digest. (ERIC Document Reproduction Service No. ED433216). Retrieved from http://www.ericdigests.org/2000-2/minorities.htm

Claxton, C. S., & Murrell, P.H. (1987). *Learning styles: Implications for improving educational practice.* Santa Barbara: CA. ASHE-ERIC Higher EDUCATION Report No. 4, ASHE College Station.

Claxton, C. S., & Murrell, P.H. (1988). *Learning styles*. ERIC Digest. (ERIC Document Reproduction Service No. ED301143). Retrieved from http://www.eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/2a/0d/da.pdf

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage Publications.

Cross, T., Bazron, B., Dennis, K., & Isaacs, M. (1989). *Towards a culturally competent system of care. Georgetown University Child Development Center*. CASSP Technical Assistance Center. Washington, DC: Author.

Darling-Hammond, L. (1985). *Equality and excellence: The education status of black Americans.* New York: College Entrance Examination Board.

Darling-Hammond, L. (1987). *Teacher quality and equality*. In P. Keating and J. I. Goodlad (Eds.), *Access to Knowledge*. New York: College Entrance Examination Board.

Darling-Hammond, L., & Hudson, L. (1989). *Indicators of teacher and teaching quality*. In R.J. Shavelson, L. McDonnell, & J. Oakes (Eds.), *Indicators for monitoring mathematics and science education*: *Background papers.* Santa Monica, CA: Rand Corporation.

Dembo, M.H. (2001). Learning to teach is not enough-future teachers also need to learn how to learn. *Teacher Education Quarterly. Fall.*

de Vries, D. (2005). Teaching Across Cultures. *Mercury* (Jul-Aug. 2005), *34*(4), 12-20.

Dewey, J. (1944). *Democracy and education*. New York: Macmillan Publishers. (Original work published 1916).

Dewey, J. (1998). *How we think* (Rev. ed). Boston, MA: Houghton Mifflin. (Original work published 1933).

Diaz, D. P., & Cartnal, R. B. (1999). Students' learning styles in two classes: Online distance learning and equivalent on-campus. *College Teaching, 47*(4), 130-135.

Driscoll, M. (2001). *Psychology of learning for assessment* (2nd ed.) Boston: Allyn and Bacon.

Dunn R. S., & Dunn, K.J. (1979). Learning styles/teaching styles: should they…can they be matched? *Educational Leadership, 36*, 238-24.

Dunn, R., Gemake, J., Jalali, F., Zenhausern, R., Quinn, P., & Zenhausern, P. (1990). Cross-cultural differences in the learning styles of fourth, fifth, and sixth grade students of African, Chinese, Greek, and Mexican heritage. *Journal of Multicultural Counseling and Development, 18,* 68-93.

Dunn, R., & Griggs, S. (1996). Hispanic-American Students and Learning Style. (ERIC Document Reproduction Service No. ED393607). Retrieved from http://www.ericdigests.org/1996-4/hispanic.htm

Dunn, R., & Griggs, S. A., Olson, J., Gorman, B., & Beasley, M. (1995). A meta-analytic validation of the Dunn and Dunn learning style model. *Journal of Educational Research, 88*(6), 353-361.

Dunn, R., Griggs, S., & Dunn, K., (1993). Learning styles of Mexican-American and Anglo-American Elementary School Students. *Journal of Multicultural Counseling and Development, 21*(4): 237-247.

Early, P. C. (1994). Self or group? Cultural effects of training on self-efficacy and performance. *Administrative Science Quaterly*, *39*(1), 89-117.

Educational Master Plan (2005). Retrieved from http://www.broward.edu/masterplan/BCCMasterPlan.pdf

Ekstrom, R. B., Goertz, M. E., & Rock, D. (1988). *Education & American youth*. Philadelphia, PA: Falmer Press.

Felder R. M. (1988). Learning and teaching styles in engineering education. *Engr. Education, 78*(7), 674-681. Author's preface. (2002).

Felder, R. (1993). Reaching the Second tier: Learning and teaching styles in college science education. *J. College Science Teaching, 23*(5), 286-290.

Felder, R. M. (1996). Matters of style. *ASEE Prism. 6*(4), 18-23.

Felder, R. M. (2005). An exploration of differences: A longitudinal study of engineering student performance and success. *J. Engr. Education*. *94*(1), 57-72. (para. 2)

Felder, R. M. (2006). *Felder's responses to frequently asked questions about the ILS.* Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/ILS-faq.htm#inductive

Felder, R. M. (2007). Richard Felder's Responses to frequently asked questions about the ILS. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/ILS-faq.htm

Felder, R. M., & Brent, R. (2005). Understanding student differences. J*ournal of Engineering Education, 94* (1), 57-72.

Felder R. M. & Silverman, L.K. (1988). Learning and teaching styles in engineering education. *Engr. Education.* 78(7), 674-681.

Felder, R. M. & Silverman, L.K. (1993). Learning and teaching styles in college science education. *Journal of science college teaching*. *23*(5), 286-290.

Felder R. M., & Silverman, L.K. (1998). Learning styles and teaching styles in engineering education. *Engr. Education, 78* (7), 674-681.

Felder, R. M., & Soloman, (1999). *Learning style inventory*. Retrieved November 12, 2007 from http://www.engr.ncsu.edu/learningstyles/ilsweb.html

Felder, R. M., & Soloman, B.A. (2000). *Index of Learning Styles*. Retrieved November 12, 2007 from http://www.ncsu.edu/felder-public/ILSpage.html

Felder, R. M., & Spurlin, J.E. (2005). Applications, reliability, and validity of the index of learning styles. *Intl. J. Engr. Education, 21*(1), 103-112.

Fleming, N. D. (1998). *VARK: a guide to learning styles*. Retrieved from http://www.vark-learn.com/english/

Fox, R. L., & Ronkowski, S. A. (1997). Learning styles of political science students. *PS: Political Science & Politics, 30*(4), 732-737.

Garcia, E. (1999). *Student cultural diversity: Understanding and meeting the challenge*. Boston: Houghton Mifflin.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic.

Gardner, H. (1993). *Multiple intelligences: The theory in practice*. New York: Basic Books.

Gazzaniga, M. S. (1985). *The social brain: Discovering the networks of the mind*. New York: Basic Books.

Goodlad, J. I. (1984). *A place called school: Prospects for the future*. New York: McGraw-Hill.

Gomez, R. A. (1999). *Teaching with a multicultural perspective*. Urbana, Illinois: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED33954)

Grasha, A. F. (1996). *Teaching with style*. Pittsburgh, PA: Alliance.

Greeno, J. (1989). A perspective on thinking. *American Psychologist, 44*,134-141.

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research, 66*(2), 361-396.

Helms, S. M. (2003). *The examination of cultural sensitivity and exhibition of cultural competences for faculty at liberal arts institutions within higher education*. Dissertation from ProQuest. (UMI No. 3107769) Retrieved from http://proquest.umi.com.ezp.waldenulibrary.org/pqdweb?index=0&did=765020231&SrchMode=1&sid=6&Fmt=6&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1205943778&clientId=70192

Hodges, S.A. (1988). Individual learning styles of student nurses, their teachers, and ward sisters. *Journal of Advanced Nursing, 13*, 341-344.

Hodgkinson, H. L. (1992). *A demographic look at tomorrow.* Washington, DC: Institute for Education Leadership Center for Demographic Policy.

Huitt, W. (2003). Constructivism. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University.

Huit, W. (2003). A systems model of human behavior. *Educational Psychology Interactive.* Valdosta, GA: Valdosta State University.

James, W. B., & Gardner, D. L. (1995). Learning Styles: Implications for Distance Learning. *New Directions for Adult and Continuing Education*, *67,* 19-32.

Jensen, E. (1998). *Teaching with the brain in mind.* Alexandria, VA: ASCD-Association for Supervision of Curriculum Development.

Jones, L.V. (1984). White-Black achievement differences: The narrowing gap. *American Psychologist*, *39*, 1207-1213.

Jung, C. G. (1971). *Psychological types.* Princeton, NJ: Princeton University Press. (Original work published 1921).

Kendall, F. E., (2006). *Understanding white privilege. Creating pathways to authentic relationships across race.* New York: Routledge.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Englewood Cliffs, NJ: Prentice-Hall.

Kreuze, J. G., & Payne, D. D. (1989). The Learning Style Preferences of Hispanic and Anglo College Students: A Comparison. *Reading Improvement*, *26*(2), 166-69.

Lang, G. (1999). *Integration strategies for integrated health systems and community behavioral health organizations.* Atlanta, GA: Behavior Health Partners.

Lindsey, R. B. & Roberts, L. M. (2005). *The culturally proficient school: An implementation guide for school leaders.* Thousand Oaks, CA: Corwin Press.

Litzinger T. A., Lee, S. H., Wise, J. C., & Felder, R. M. (2005). A study of the reliability and validity of the Felder-Soloman index of learning styles. *Proceedings, 2005 ASEE Annual Conference, American Society for Engineering Education, June.*

Livesay, G. A., Dee. K. C., Nauman, E. A., and Hites, Jr., L. S. (2002). Engineering student learning styles: A statistical analysis using Felders' index of learning styles. Paper presented at the *2002 ASEE Conference and Exposition*, Montreal, Quebec.

Lutz, S., & Huitt, W. (2004). Connecting Cognitive Development and Constructivism: Implications from Theory for Instruction and Assessment. *Constructivism in the Human Science, 9*(1), 67-90.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications or Cognition, Emotion, and Motivation. *Psychological review. 98*(2), *224-253*.

McCaulley, M. H. (1990). The MBTI and individual pathways in engineering design. *Engr. Education*, *80*, 537-542.

Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. *Trends in cognitive sciences*, *9*(10), 467-473.

McLaughlin, B., & McLeod, B. (1996). Educating all our students: Improving education for children from culturally and linguistically diverse backgrounds. *National center for research on cultural diverse and second language learning*. Santa Cruz, CA: University of California Santa Cruz.

McLaughlin, M. W., & Talbert, J. (2001). *Professional communities and the work of high school teaching.* Chicago: University of Chicago Press.

Merriam, S. B., & Caffarella, R. S. (1991). *Learning in adulthood: A comprehensive guide.* San Francisco: Jossey Bass.

Miami Dade College Fact Book (2005). *Highlights and facts on enrollment.* Retrieved from http://www3.mdc.edu/ir/fbind.asp

Murphy, R. J, Gray, S. A., Straja, S. R., & Bogert, M. C. (2004). Student learning preferences and teaching implications. *Journal of Dental Education*, *68*(8), 859-866.

National Commission on Teaching and America's Future [NCTAF]. 2003. *No Dream Denied: A Pledge to America's Children.* Washington, DC.

National Council of LaRaza. (2006). *Latino Demographics by State* [Fact Sheet]. Retrieved from http://www.nclr.org/section/audience/policy/state_fact_sheets_policymakers

National Science Board Commission on Pre-college Education in Mathematics, Science and Engineering. NSB. (2006). *America's Pressing Challenge – Building a stronger foundation: A companion to national science foundation indicators*, p. 2. Retrieved from http://www.nsf.gov/statistics/nsb0602/

National Science Board, Science and Engineering Indicators [NSBI]. (2006). (NSB 06-01, p. 5) Arlington, VA: National Science Foundation.

National Science Foundation (1996). *Women, minorities, and persons with disabilities in science and engineering.* Washington, DC: Author.

National Science Foundation STEM Workshop Report (2005). Retrieved from http://www.seas.gwu.edu/~stem/current.htm

National Science Foundation Science and Engineering Indicators Report [NSFS&E]. (2006). Chapters 1-3, Appendix Tables 2-5. Retrieved from http://www.nsf.gov/statistics/seind06/c3/c3s1.htm

Nelson, D. J., & Rogers, D. C. (2004). *A National Analysis of Diversity in science and engineering faculties at research universities*. NOW Report. Retrieved from http://www.now.org/issues/diverse/diversity_report.pdf

Nisbett, R. E. & Miyamoto, Y. (2005). The infIuence of culture: Holistic versus analytic perception. T*rends in Cognitive Sciences,* Oct.2005, *9*(10), 467-473.

No Child Left Behind Act of 2001 [NCLB]. Retrieved from http://www.nochildleftbehind.com/

Nuri Robins, K., Lindsey, R. B., Lindsey, D. B., Terrell, R. D. (2002). *Culturally proficient instruction: A guide for people who teach*. Thousand Oaks, CA: Corwin Press.

Oakes, J., Ormseth, T, Bell, R. M., Camp, P. (1990). *Multiplying inequalities: The effects of races, social class, and tracking on opportunities to learn mathematics and science.* Santa Monica, CA: Rand Publishing.

Ogden, D. T., Ogden, J. R., Schau, H. J. (2004). *Exploring the Impact of Culture and Acculturation of Consumer Purchase Decisions: Toward a Microcultural Perspective.* Academy of Marketing Science Review, *3*. Retrieved from http://www.amsreview.org/articles/ogden03-2004.pdf

Ogbu, J. U. (1992). Understanding Cultural Diversity and Learning. *Educational Researcher*, *21*(8), 5-14.

Pearson Calculator. (2007). Retrieved from http://survey.pearsonassessments.com/resources/sample-calc.htm

Pederson, P. (1994). *Handbook for developing multicultural awareness*. Alexandria, V.A.: American Association for Counseling and Development.

Piaget, J. (1972). *The psychology of the child*. New York: Basic Books.

Piaget, J. (2001). The psychology of intelligence (2nd. ed) London: Routledge. (Original work published 1950).

Pues, S. E. (1994). *I have got style: A learning style manual for the adult learner*. Seattle, WA: Aeon-Hierophant.

Richardson, J. T. E. (1994). Cultural specificity of approaches to studying in higher education: A literature survey. *Higher Education, 27*(4).

Rock, D., Braun, H. I., & Rosenbaum, P. R. (1985). *Excellence in high school education: Cross-sectional study*, *1980-1982*. Princeton, NJ: Educational Testing Service.

Sauceda-Castillo, M.J. (2001). *Learning styles: a comparative study of cultural differences in African-American, Anglo-American, Asian-American, and Hispanic-American accounting students in Texas public universities*. ProQuest Dissertation. (UMI No. 3033870) Retrieved from http://proquest.umi.com.ezp.waldenulibrary.org/pqdweb?index=0&sid=2&srchmode=1&vinst=PROD&fmt=6&startpage=-1&clientid=70192&vname=PQD&RQT=309&did=726089521&scaling=FULL&ts=1205943129&vtype=PQD&rqt=309&TS=1205943148&clientId=70192

Schermerhorn, R. A. (1970). *Comparative ethnic relations: A framework for theory and research.* New York: Random House.

Schuhman, A. (1992). *Learning to teach Hispanic students*. In M. Dilworth's *Diversity in teacher education-new expectations.* New York: Jossey-Bass.

Singer, A. J. (2003). *Teaching to learn: Learning to teach: A handbook for secondary school teachers*. Mahwah, Jew Jersey: Lawrence Erlbaum Associates.

Slavin, R. E. (1987). *A review of research on elementary ability grouping*. Baltimore, MD: Johns Hopkins University Press.

Soloman, B. A. and Felder, R. M. (1999) *Index of learning styles*. Retrieved from http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSpage.html

Spindler, L. S., (1984). *Culture change and modernization:Mini-models and case studies*. Prospect Heights, Ill: Waveland Press.

Springer, A. (2003). *Update on affirmative action in higher education: A current legal overview.* (ERIC Document Reproduction Service No. ED480162). Retrieved from http://eric.ed.gov/ERICWebPortal/custom/portlets/recordDetails/detailmini.jsp?_nfpb=true&_&ERICExtSearch_SearchValue_0=ED480162&ERICExtSearch_SearchType_0=ericaccno&accno=ED480162

Stern. J. D. (1994). *The condition of education in rural schools*. Washington, DC: U.S. Department of Education, Office of Educational and Research Improvement.

Stoughton, E. H. & Sivertson, C. (2005). Communicating across cultures: discursive challenges and racial identity formation in narratives of middle school students. *Race, Ethnicity & Education*, *8*(3), 277-295.

Tanner, K., & Allen, D. (2004). Approaches to biology teaching and learning: Learning styles and the problem of instructional selection–engaging all students in science courses. *Cell Biology Education, 3*, 197-201.

Tate, A. B. (2003). *Project demonstrating excellence: Examination of learning styles to determine the specific differences between African American and Caucasian Females in Howard County, Maryland*. ProQuest Dissertation. Retrieved from http://proquest.waldenu.edu/pqdweb?index=0&did=766103121&SrchMode=1&sid=2&Fmt=2&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1181508981&clientId=70192

Tennant, M., (2002). *Psychology and adult learning*. New York, NY: Routledge.

Tobias, S. (1990). *They're not dumb, they're different: Stalking the second tier*. Tucson, AZ: Research Corporation.

Torres, R.M. & Cano, J. (1994). Learning styles of students in a college of agriculture. *Journal of Agricultural Education, 35*(4), 61-66, 64.

Trower, C.A. (2002). Why so few minority faculty and what to do? Diversifying the regions' professoriate. *New England's Journal of Higher Education.* Fall. Retrieved from http://findarticles.com/p/articles/mi_qa3895/is_200210/ai_n9087962

Tsui, J.S.L. (1996). Auditor's ethical reasoning: Some audit conflict and cross cultural evidence. *The International Journal of Accounting, 31*(1), 121-133.

U.S. Bureau of the Census, Current Population Survey. (2000). Annual series; and U.S. Bureau of the Census, *Projections of the Total Resident Population by 5-Year Age Groups, and Sex With Special Age Categories: Middle Series, 1999 to 2100*, NP-T3. Retrieved from http://www.census.gov/population/www/projections/natsum-T3.html

U.S. Bureau of the Census, County Population Estimates by Demographic Characteristics - Age, Sex, Race, and Hispanic Origin; (2005). updated annually for states and counties. Retrieved from http://www.census.gov/popest/counties/asrh/. *2000 Census of Population and Housing for places; updated every 10 years.* Retrieved May 14, 2007, from http://factfinder.census.gov

USDA. (2005). *Research and Development* (RD) 2045 Plan. Retrieved from http://www.rurdev.usda.gov/regs/regs/pdf/2045z.pdf.

USDA ARS Workforce Plan 2006-2010. (2006). Retrieved from http://www.afm.ars.usda.gov/hrd/humancapital/ARS%20Workforce%20Plan.doc

U.S. Department of Education. (2000). *National commission on mathematics and science teaching for the 21st century, before it's too late.* Washington, DC.

Vygotsky, L. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wakefield, A.P. (1993). Learning styles and learning dispositions in public schools: Some implications of preference. *Education*, *113*(3), 402-405.

Wang, M.C., Haertel, G.D., & Walberg, H.J. (1997). What helps students learn? LSS:Laboratory of Student Success. (No.209). Adapted from Synthesis of research: What helps students learn? *Educational Leadership*, December 1993-January 1994, 74-79. Retrieved from http://www.temple.edu/lss/htmlpublications/spotlights/200/spot209.htm

Wang, M.C., Haertel, G.D., & Walberg, H.J. (1997). What helps students learn? Spotlight on student success. Laboratory for Student Success. (ERIC Document Reproduction Service No. ED461694). Retrieved February 25, 2007, from http://eric.ed.gov/ERICDocs/data/ericdocs2/content_storage_01/0000000b/80/0d/be/44.pdf

Yong, F., & Ewing, N., (1992). A comparative study of the learning style preferences among gifted African-American, Mexican-American, and American Born Chinese Middle Grade Students. *Roeper Review, 14*(3), 120-123.

Zywno, M. (2002). Instructional technology, learning styles, and academic achievement. *Proceedings, 2002 ASEE Conference and Exposition*, Washington, D.C.: American Society for Engineering Education.

Zywno, M. (2003). A contribution to validation of score meaning for Felder-Soloman's index of learning styles. *Proceedings, 2003 ASEE Annual Conference,* American Society for Engineering Education.

APPENDIX A

Index of Learning Styles

NC STATE UNIVERSITY

Index of Learning Styles Questionnaire

BARBARA A. SOLOMAN
FIRST-YEAR COLLEGE
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA 27695
RICHARD M. FELDER
DEPARTMENT OF CHEMICAL ENGINEERING
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NC 27695-7905

Directions

Please provide us with your full name. Your name will be printed on the information that is returned to you.

Full Name

For each of the 44 questions below select either "a" or "b" to indicate your answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently. When you are finished selecting answers to each question please select the submit button at the end of the form.

1. I understand something better after I
   - **(a)** try it out.
   - **(b)** think it through.
2. I would rather be considered
   - **(a)** realistic.
   - **(b)** innovative.
3. When I think about what I did yesterday, I am most likely to get

- ☐ **(a)** a picture.
- ☐ **(b)** words.

4. I tend to
   - ☐ **(a)** understand details of a subject but may be fuzzy about its overall structure.
   - ☐ **(b)** understand the overall structure but may be fuzzy about details.
5. When I am learning something new, it helps me to
   - ☐ **(a)** talk about it.
   - ☐ **(b)** think about it.
6. If I were a teacher, I would rather teach a course
   - ☐ **(a)** that deals with facts and real life situations.
   - ☐ **(b)** that deals with ideas and theories.
7. I prefer to get new information in
   - ☐ **(a)** pictures, diagrams, graphs, or maps.
   - ☐ **(b)** written directions or verbal information.
8. Once I understand
   - ☐ **(a)** all the parts, I understand the whole thing.
   - ☐ **(b)** the whole thing, I see how the parts fit.
9. In a study group working on difficult material, I am more likely to
   - ☐ **(a)** jump in and contribute ideas.
   - ☐ **(b)** sit back and listen.
10. I find it easier
    - ☐ **(a)** to learn facts.
    - ☐ **(b)** to learn concepts.
11. In a book with lots of pictures and charts, I am likely to
    - ☐ **(a)** look over the pictures and charts carefully.
    - ☐ **(b)** focus on the written text.
12. When I solve math problems
    - ☐ **(a)** I usually work my way to the solutions one step at a time.
    - ☐ **(b)** I often just see the solutions but then have to struggle to figure out the steps to get to them.
13. In classes I have taken
    - ☐ **(a)** I have usually gotten to know many of the students.
    - ☐ **(b)** I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
    - ☐ **(a)** something that teaches me new facts or tells me how to do something.
    - ☐ **(b)** something that gives me new ideas to think about.
15. I like teachers
    - ☐ **(a)** who put a lot of diagrams on the board.
    - ☐ **(b)** who spend a lot of time explaining.
16. When I'm analyzing a story or a novel
    - ☐ **(a)** I think of the incidents and try to put them together to figure out the themes.
    - ☐ **(b)** I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.
17. When I start a homework problem, I am more likely to
    - ☐ **(a)** start working on the solution immediately.
    - ☐ **(b)** try to fully understand the problem first.
18. I prefer the idea of
    - ☐ **(a)** certainty.
    - ☐ **(b)** theory.
19. I remember best
    - ☐ **(a)** what I see.
    - ☐ **(b)** what I hear.
20. It is more important to me that an instructor
    - ☐ **(a)** lay out the material in clear sequential steps.
    - ☐ **(b)** give me an overall picture and relate the material to other subjects.
21. I prefer to study
    - ☐ **(a)** in a study group.
    - ☐ **(b)** alone.
22. I am more likely to be considered
    - ☐ **(a)** careful about the details of my work.
    - ☐ **(b)** creative about how to do my work.
23. When I get directions to a new place, I prefer
    - ☐ **(a)** a map.
    - ☐ **(b)** written instructions.
24. I learn
    - ☐ **(a)** at a fairly regular pace. If I study hard, I'll "get it."

- ☐ **(b)** in fits and starts. I'll be totally confused and then suddenly it all "clicks."

25. I would rather first
    - ☐ **(a)** try things out.
    - ☐ **(b)** think about how I'm going to do it.
26. When I am reading for enjoyment, I like writers to
    - ☐ **(a)** clearly say what they mean.
    - ☐ **(b)** say things in creative, interesting ways.
27. When I see a diagram or sketch in class, I am most likely to remember
    - ☐ **(a)** the picture.
    - ☐ **(b)** what the instructor said about it.
28. When considering a body of information, I am more likely to
    - ☐ **(a)** focus on details and miss the big picture.
    - ☐ **(b)** try to understand the big picture before getting into the details.
29. I more easily remember
    - ☐ **(a)** something I have done.
    - ☐ **(b)** something I have thought a lot about.
30. When I have to perform a task, I prefer to
    - ☐ **(a)** master one way of doing it.
    - ☐ **(b)** come up with new ways of doing it.
31. When someone is showing me data, I prefer
    - ☐ **(a)** charts or graphs.
    - ☐ **(b)** text summarizing the results.
32. When writing a paper, I am more likely to
    - ☐ **(a)** work on (think about or write) the beginning of the paper and progress forward.
    - ☐ **(b)** work on (think about or write) different parts of the paper and then order them.
33. When I have to work on a group project, I first want to
    - ☐ **(a)** have "group brainstorming" where everyone contributes ideas.
    - ☐ **(b)** brainstorm individually and then come together as a group to compare ideas.
34. I consider it higher praise to call someone
    - ☐ **(a)** sensible.
    - ☐ **(b)** imaginative.

35. When I meet people at a party, I am more likely to remember
    - ☐ **(a)** what they looked like.
    - ☐ **(b)** what they said about themselves.
36. When I am learning a new subject, I prefer to
    - ☐ **(a)** stay focused on that subject, learning as much about it as I can.
    - ☐ **(b)** try to make connections between that subject and related subjects.
37. I am more likely to be considered
    - ☐ **(a)** outgoing.
    - ☐ **(b)** reserved.
38. I prefer courses that emphasize
    - ☐ **(a)** concrete material (facts, data).
    - ☐ **(b)** abstract material (concepts, theories).
39. For entertainment, I would rather
    - ☐ **(a)** watch television.
    - ☐ **(b)** read a book.
40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
    - ☐ **(a)** somewhat helpful to me.
    - ☐ **(b)** very helpful to me.
41. The idea of doing homework in groups, with one grade for the entire group,
    - ☐ **(a)** appeals to me.
    - ☐ **(b)** does not appeal to me.
42. When I am doing long calculations,
    - ☐ **(a)** I tend to repeat all my steps and check my work carefully.
    - ☐ **(b)** I find checking my work tiresome and have to force myself to do it.
43. I tend to picture places I have been
    - ☐ **(a)** easily and fairly accurately.
    - ☐ **(b)** with difficulty and without much detail.
44. When solving problems in a group, I would be more likely to
    - ☐ **(a)** think of the steps in the solution process.
    - ☐ **(b)** think of possible consequences or applications of the solution in a wide range of areas.

When you have completed filling out the above form please click on the Submit button

below. Your results will be returned to you. If you are not satisified with your answers above please click on Reset to clear the form.

Submit Reset

Dr. Richard Felder, felder@ncsu.edu

Retrieved 2-18-08 from http://www.engr.ncsu.edu/learningstyles/ilsweb.html

APPENDIX B

Permission Letter

BROWARD COMMUNITY COLLEGE

Opening doors to a brighter future

Office of the Vice President for Academic Affairs • Willis Holcombe Center
954-201-7426 • Fax 954-201-7576

WILLIS HOLCOMBE CENTER
111 East Las Olas Blvd.
Fort Lauderdale, FL 33301

INSTITUTE FOR ECONOMIC DEVELOPMENT
111 East Las Olas Blvd.
Fort Lauderdale, FL 33301

A. HUGH ADAMS CENTRAL CAMPUS
3501 S.W. Davie Road
Davie, FL 33314

NORTH CAMPUS
1000 Coconut Creek Blvd.
Coconut Creek, FL 33066

JUDSON A. SAMUELS SOUTH CAMPUS
7200 Hollywood/Pines Blvd.
Pembroke Pines, FL 33024

PINES CENTER
16957 Sheridan St.
Pembroke Pines, FL 33331

WESTON CENTER
4205 Bonaventure Blvd.
Weston, FL 33332

MIRAMAR CENTER
7451 Riviera Blvd.
Miramar, FL 33023

TIGERTAIL LAKE CENTER
580 Gulfstream Way
Dania Beach, FL 33004

August 31, 2007

Mattie Roig
Associate Vice President for Career and Technical Education
Broward Community College
225 East Las Olas Blvd.
Fort Lauderdale, FL 33301

Dear Ms. Roig:

Your request to conduct research at Broward Community College for your doctoral dissertation on "The Relationship Between Learning Style Preference and Achievement in the Adult Student in a Multicultural College" from Walden University has been granted. The conditions of your research are:

- participation is voluntary
- the student's identity will be kept anonymous when you report your results
- access to students in a classroom will not be permitted without faculty permission
- this research cannot have a negative impact on the student

I wish you luck with your research and if I can be of any further assistance please do not hesitate to contact me.

Sincerely,

Kenneth S. Ross
Vice President for Academic Affairs

APPENDIX C

Letter to Instructors

Introduction and Instructions to Faculty

Hello, my name is Matilde Roig and I am doing a research project for my Ed.D. I am a student at Walden University and am working on my Ed.D doctoral degree in Teacher Leadership. I am an employee here, at the college and have been a faculty in biology since 1990, teaching college students. There is no conflict of interest. The research project is designed to learn about college student learning styles and the relationship to achievement in biology courses. The title of the research study is "The Relationship Between Learning Style Preference and Achievement in the Adult Student in a Multicultural College."

The purpose of this study is to examine the relationship between learning style preferences and achievement (grades) by adult minority students in a multicultural college. The overall purpose is to learn which learning styles are preferred so that recommendations can be provided regarding teaching methods that may best fit the student population.

I am inviting you to join my project on a volunteer basis. Your class was picked using a lotto style drawing after the 100% drop date. The collegewide population and sample size of biology students was determined for this project. All reference numbers for biology were placed in a box and numbers drawn corresponding to the sample size determined. Your class was picked which is why you are receiving this invitation to participate in my study.

Participation on your part is voluntary as that of students enrolled in your classes. If you agree to participate, it will be appreciated. Your part in the study is not labor intensive. It entails the following:

1. Assignment of a number ID to each student. Each faculty will be given a letter to prefix the number. If the instructor's name is Jones, the student ID will be J-#.
2. A three question demographics questionnaire for gender, ethnicity and race is provided. This survey is used by the college in part. This takes less than 3 minutes to complete by the student. If possible, I would like to attend your class and distribute and collect these. I will also discuss with the students the project and their voluntary participation in the project. The whole discussion should not take more than 5 minutes of your classtime.
3. The Felder –Soloman Learning Style (LSI) Inventory will be completed by the student. It takes about 20 minutes to complete. Students can take the LSI online. The URL is http://www.engr.ncsu.edu/learningstyles/ilsweb.html. An immediate response is provided to the student.

- You can take students as a group to an electronic classroom or environment such as the Learning Resource Center or students can take the LSI from home. Either way, students click on their responses to the LSI questions and will submit at the end of the survey for the results.
- Students should hand in to you the results. Please make sure that they have their ID number on that results page. Students will have one week to hand in the results to you.
- You will hand in the result pages to me at the end of the week.

4. At the end of the semester, you will provide the final grades by ID number to me for relationship to LSI restults.

The relationships of the learning style preferences to student achievement as measured by final grade will be statistically determined. Additional factors will also be correlated such as gender, race and ethnicity.

About this Project

It's possible that being in this project might help students gain knowledge about individual learning styles and how to best use this knowledge to study and learn. In addition, if students learn about their own learning style can help their educational career by being able to choose methods of learning most appropriate for their learning needs as well as instructors that teach using methods that are congruent to their learning styles. In addition, this project might help faculty learn about the learning style preferences as they relate to culture and minority groups, and implementation of learning strategies. There is no penalty for nonparticipation in the research project. The survey will not cause any discomfort to you or your students.

PRIVACY:

Everything you do in this project will remain anonymous. Instructor and student identity is protected and not revealed. Only you, the instructor will know the student ID and name, however you will not be provided with an individual's result pertaining to the LSI or any other data. That means that no one else will know a name or whatever answers were provided. Only the number ID will be used at all times.

ASKING QUESTIONS:

You can ask me any questions you want now. If you think of a question later, you or your parents can reach me at mroig@broward.edu or 954-201-7811 or my professor at stephanie.helms@waldenu.edu . If you would like to ask my university a question, you can call Dr. Leilani Endicott. Her phone number is 1-800-925-3368, extension 1210.

Instructions for filling out the LSI will be provided to students.

Please remember that your anonymity is maintained at all times and that no one will know your responses to any questions or your final results.

I encourage you, the instructor to learn about the Felder-Soloman LSI and the categories for learning style preferences. You can read this online at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm about "Learning Styles and Strategies (Felder and Soloman, 2003).

I hope that you agree to volunteer and assist me in this research project. If you decide to participate, please contact me so that I can attend your class for the introduction and instructions to students.
The timeline will be provided in the email enclosing this letter. You are to keep a copy of this form for your records.

Thank you.

Matilde Roig

APPENDIX D

Introduction and Instructions to Students

Hello, my name is Matilde Roig and I am doing a research project for my Ed.D. I am a student at Walden University and am working on my Ed.D doctoral degree in Teacher Leadership. I am an employee here, at the college and have been a faculty in biology since 1990, teaching college students. There is no conflict of interest in this research project. The research project is designed to learn about college student learning styles and the relationship to achievement in biology courses. The title of the research study is "The Relationship Between Learning Style Preference and Achievement in the Adult Student in a Multicultural College."

The purpose of this study is to examine the relationship between learning style preferences and achievement (grades) by adult minority students in a multicultural college. The overall purpose is to learn which learning styles are preferred so that recommendations can be provided regarding teaching methods that may best fit the student population.

I am inviting you to join my project on a volunteer basis. I picked you for this project because you are enrolled in a biology course. Selection of courses for this study was done randomly using a lotto style picking of course reference numbers after the 100% drop date. The instructors of each of the classes selected were contacted and asked to voluntarily participate in the research study. I am going to read this form with/to you. You can ask any questions you have before you decide if you want to do this project.

ABOUT THE PROJECT:

If you agree to join this project, you will be asked to:

- Fill in a learning style inventory. Using the Felder Soloman Learning Style Inventory (LSI) online at http://www.engr.ncsu.edu/learningstyles/ilsweb.html. This can be completed in the LRC, electronic classroom or from home. Depending on scheduling and your instructor's choice. You need to print out the results from the LSI and hand in your results to your instructor. You have one week to do this and return the result, though the actual LSI takes about 20 minutes to do.
- Fill in a three question demographics questionnaire for gender, ethnicity and race. This is done today. You will use only the ID number provided by your instructor wherever you need to place a 'name. both in the LSI and demographics questionnaire.

You don't have to join this project if you don't want to. You won't get into trouble with your instructor in this course if you say no. There is not compensation for anyone participating in the study. If you decide now that you want to join the project, you can

still change your mind later just by telling the instructor. You have the one week period to do so. However, it is appreciated if you agree to volunteer and participate.

It's possible that being in this project might help you by gaining knowledge about your individual learning style and how to best use this knowledge to study and learn. In addition, knowing about your own learning style can help you in your educational career by being able to choose methods of learning most appropriate for your learning needs as well as instructors that teach using methods that are congruent to your learning styles. In addition, this project might help faculty learn about the student learning style preferences as they relate to culture and minority groups, and implementation of learning strategies.

PRIVACY:
Everything you do in this project will remain anonymous. Your identity is protected and not revealed. Only your instructor will know your ID number but will not know individual results pertaining to your ID. That means that no one else will know your name or what answers you gave. Your ID will be a number assigned to you by your instructor. That is the only ID you should use. There is no penalty for nonparticipation in the research project. The survey will not cause any discomfort to you.

ASKING QUESTIONS:
You can ask me any questions you want now. If you think of a question later, you or your parents can reach me at mroig@broward.edu or 954-201-7811 or my professor at stephanie.helms@waldenu.edu . If you would like to ask my university a question, you can call Dr. Leilani Endicott. Her phone number is 1-800-925-3368, extension 1210.

Instructions for the Survey:

1. Fill out the Demographics Questionnaire provided. It has three questions on gender, race and ethnicity. Use your number ID
2. The Felder-Soloman Learning Style (LSI) Survey is found online at http://www.engr.ncsu.edu/learningstyles/ilsweb.html. Fill in the best answer as it applies by using the computer mouse and clicking in the response that is best for you. Use the number ID for your name. When you are done, click on submit and you will obtain your LSI response.
3. Print out the response page.
4. Hand the response page to your instructor. Please make sure your ID number is on that page.
5. Your instructor will provide me, the researcher with the response page.

Please remember that your anonymity is maintained at all times and that no one will know your responses to any questions or your final results.

I encourage you, the student to learn about your learning style preferences and read online at http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm about "Learning Styles and Strategies (Felder and Soloman, 2003).

I hope that you agree to volunteer and assist me in this research project. You, as the voluntary participant may keep a copy of this form for your record.

Thank you.

Matilde Roig

APPENDIX E

Permission to Use Index of Learning Styles

Date:	Sun, 24 Jun 2007 14:56:18 -0400 (GMT-04:00)
From:	"Richard Felder" <rmfelder@mindspring.com> Add to Address Book Add Mobile Alert Yahoo! DomainKeys has confirmed that this message was sent by mindspring.com. Learn more
To:	"Matildw Roig" <matilderoig@yahoo.com>
Subject:	Re: ILS in Research

Dear Mattie,

If you go to my Web site, www.ncsu.edu/felder-public, click on the link to "Index of Learning Styles," and then click on the "Frequently-Asked Questions" link, you'll find the procedure you need to go through (which in your case would be signing a confidentiality agreement) to get the pencil-and-paper version of the ILS.

Sincerely,
Richard Felder

-----Original Message-----
From: Matilde Roig
Sent: Jun 24, 2007 2:10 PM
To: rmfelder@mindspring.com
Cc: matilderoig@yahoo.com
Subject: ILS in Research

Hello Dr. Felder,
I would like to introduce myself, I am Mattie Roig and I am the Assoc. VP for Career and Tech Career Education at Broward Community College. I am doing my doctorate at Walden University and am concentrating my research on the Relationship between learning style preference and student achievement. I am particularly concentrating it on minorities in science. As you know, the need for science educated students in growing and particularly, in underrepresented groups which usually do not have much success in science. I am concentrating in biology classes for my research. Like you, with engineering students, I am focused on a section of science, biology, which is my subject area.

Regards,
Mattie Roig

Permission to use the Felder Soloman Learning Style Inventory is found online at :
http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/ILS-faq.htm

The following is the actual page with the answers. Please see number six.

Richard Felder's Responses to
Frequently Asked Questions about the ILS

Click on your selection.

1. *Why do I get an error message when I submit the questionnaire?*
2. *How can I get my results back after I fill out the ILS?*
3. *How did the ILS originate, and what is its theoretical basis?*
4. *What is known about the reliability and validity of the ILS?*
5. *May I build a link to the ILS on my web site?*
6. *May I use the ILS in my research? How should I cite it in reference lists?*
7. *May I administer the ILS to my college students, employees, or clients?*
8. *May I administer the ILS to my pre-college students? If not, then what* can *I administer to them?*
9. *May I get the scoring key for the questionnaire and/or the code for the web-based version?*
10. *May I get copies of my students' profiles when they complete the questionnaire?*
11. *What does it mean if I could have answered most of the questions either way?*
12. *Why isn't the inductive-deductive dimension assessed on the ILS?*
13. *Why "visual-verbal" and not "visual-auditory-kinesthetic"?*
14. *Since we see written words, why are they not included in the visual category?*
15. *Where can I find out more about the learning style dimensions assessed on the ILS?*

6. May I use the ILS in my research? How should I cite it in reference lists?

You are welcome to do so. If you use it and/or publish anything related to the instrument or data obtained with it, please include the citation

Richard M. Felder and Barbara A. Soloman, *Index of Learning Styles*, <http://www.ncsu.edu/felder-public/ILSpage.html>, accessed _____ [insert the most recent date of access].

APPENDIX F

Request to Conduct Study at the College

August 30, 2007

To: Dr. Ken Ross
Vice President for Academic Affairs

From: Mattie Roig
Associate Vice President for Career and Technical Education

Re: Doctoral Study Research

My doctoral study at Walden University is based on Teacher Leadership in the Doctor of Education Program. My emphasis of study is on student achievement, especially that of adult minority students.

Purpose and Rationale

The research that I propose is on the relationship between learning style preference and student achievement, particularly, focusing on minority students. I intend to use biology classes for my sample selection and would like to conduct my study at one of the campuses, perhaps South Campus. The literature research shows that students learn differently and that culture influences learning and, therefore, different learning styles may be preferred by certain minority groups.

The research I propose is innovative in that there is a great need to educate future students in the sciences to increase the career opportunities in education and in science research. It is predicted that in about a decade, 50% of the scientists will retire, leaving the U.S. with a huge deficit in scientists. Under-represented groups, such as Hispanics and Blacks, as well as others, traditionally do not enter science careers and few are in science and math education. The research I propose has the potential to change how we view education for minorities. It is a study that can be duplicated in other science courses, as well as, other fields and mostly in programs. In my new position, at BCC, I see that this study can open doors to how we educate minorities in programs as well as how studies can be done to ascertain and correlate teaching styles to learning style preferences.

Description of Method Design

I would like to conduct my study at BCC, either in the fall (2008-1) or winter term (2008-2) depending on when Walden University's Institutional Review Board provides approval

to do so. The format for the quantitative study is a "one-shot" survey on Learning Styles. The research project is simply done in three steps:
1) I will use the Felder-Soloman Learning Style Inventory which is found online: http://www.engr.ncsu.edu/learningstyles/ilsweb.html. Students will take the online test and have an immediate response. The students will be given a number in each class. The number will serve as their 'name' and only the instructor of record will know which number corresponds to which student. The student will print out the result with their 'number' on it. I will pay for all printing of results.
2) In addition, each student will fill out a brief personal demographic questionnaire (Student gender, ethnicity and race, age group).
3)At the end of the course/semester, the instructor will provide me with a list of grades and the number of the student.

Anonymity of the student will be maintained. All classes will be selected at random and depending on the number of biology classes available for the population, the sample size will be calculated. Instructors will be asked to voluntarily participate in the project. If an electronic class is not available, students will be given a hard copy and scoring will be done manually or submitted electronically to the web site.

The study will not harm any student and will always be overseen by me, in accordance with the instructor of the course.

Research Results

The research results will be made available to BCC when published. The study can be duplicated and used to assist with courses and programs to help increase student achievement not only with minorities but with all students.

I would appreciate consideration allowing me to conduct the research at BCC. Improving student achievement has always been an integral aspect of BCC's mission, and particularly, that of the growing minority sector. I wish to be part of the evolution in continuing this endeavor.

For my research, I request a letter approving my study to be conducted at BCC once IRB provides permission.

APPENDIX G

Demographics Questionnaire

Demographics Questionnaire

Obtained from the "Voluntary Equal Employment Opportunity Supplement" at the College.

Number ID _____

Please fill in the following information. Do not use your name but only the number ID provided by your instructor. When you finish, fold this and hand it to the instructor or researcher.

1. Gender: Check one (1)

   _____ Male _____ Female

2. Check one (1) of the following that applies to your: (Race definitions below)

   _____ White _____ Black or African American

   _____ Asian _____ American Indian & Alaska Native

   _____ Native Hawaiian & Other Pacific Islander _____ Some other race alone

3. Check one (1) of the following that applies to you:

   _____ Hispanic _____ Non-Hispanic

How are the race categories used in Census 2000 defined?

"White" refers to people having origins in any of the original peoples of Europe, the Middle East, or North Africa. It includes people who indicated their race or races as "White" or wrote in entries such as Irish, German, Italian, Lebanese, Near Easterners, Arab, or Polish.	"Black or African American" refers to people having origins in any of the Black racial groups of Africa. It includes people who indicated their race or races as "Black, African Am., or Negro," or wrote in entries such as African American, Afro American, Nigerian, or Haitian.
"Asian" refers to people having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent. It includes people who indicated their race or races as "Asian Indian, Chinese, Filipino, Korean, Japanese, Vietnamese, or other Asian," or wrote in entries such as Burmese, Hmong, Pakistani, or Thai.	"Native Hawaiian and Other Pacific Islander" refers to people having origins in any of the original peoples of Hawaii, Guam, Samoa, or other Pacific Islands. It includes people who indicated their race or races as "Native Hawaiian, Guamanian, or Chamorro, Samoan," or "Other Pacific Islander," or wrote in entries such as Tahitian, Mariana Islander, or Chuukese.
"American Indian and Alaska Native" refers to	"Some other race" was included n Census 2000 for

people having origins in any of the original peoples of North and South America (including Central America), and who maintain tribal affiliation or community attachment. It includes people who indicated their race or races by marking this category or writing in their principal or enrolled tribe, such as Rosebud Sioux, Chippewa, or Navajo.	respondents who were unable to identify with the five Office of management and Budget race categories.

Note: When a list of races is provided to respondents, the list should not contain a "multiracial" category. From Office of Management Budget (OMB) U.S. Census 2000 retrieved from http://www.census.gov/population/www/socdemo/race/Ombdir15.html

APPENDIX H

Institutional Research Board Approval

From:	"IRB" <IRB@waldenu.edu> Add to Address Book Add Mobile Alert
To:	"Matildw Roig" <matilderoig@yahoo.com>
CC:	"Doctoral Study" <DoctoralStudy@waldenu.edu>, shelms@waldenu.edu, "eddadvise/Walden/OHE" <eddadvise/Walden/OHE@OHEMINN.laureate-inc.com>
Subject:	Roig IRB materials approved
Date:	Fri, 2 Nov 2007 11:16:31 -0500

Dear Ms. Roig:

This email is to notify you that the Institutional Review Board (IRB) has approved your application for the study entitled, "The Relationship Between Learning Style Preferenceand Achievement in the Adult Student in a Multicultural College."

Your approval # is 11-02-07-318065. You will need to reference this number in the appendix of your doctoral study and in any future funding or publication submissions.

Your IRB approval expires on November 2, 2008. One month before this expiration date, you will be sent a Continuing Review Form, which must be submitted if you wish to collect data beyond the approval expiration date.

Your IRB approval is contingent upon your adherence to the exact procedures described in the final version of the IRB application materials that have been submitted as of this date. If you need to make any changes to your research staff or procedures, you must obtain IRB approval by submitting the IRB Request for Change in Procedures Form. You will receive an IRB approval status update within 1 week of submitting the change request form and are not permitted to implement changes prior to receiving approval. Please note that Walden University does not accept responsibility or liability for research activities conducted without the IRB's approval, and the University will not accept or grant credit for student work that fails to comply with the policies and procedures related to ethical standards in research.

When you submitted your IRB application, you a made commitment to communicate

both discrete adverse events and general problems to the IRB within 1 week of their occurrence/realization. Failure to do so may result in invalidation of data, loss of academic credit, and/or loss of legal protections otherwise available to the researcher.

Both the Adverse Event Reporting form and Request for Change in Procedures form can be obtained at the IRB section of the Walden web site or by emailing irb@waldenu.edu: http://inside.waldenu.edu/c/Student_Faculty/StudentFaculty_4274.htm

Researchers are expected to keep detailed records of their research activities (i.e., participant log sheets, completed consent forms, etc.) for the same period of time they retain the original data. If, in the future, you require copies of the originally submitted IRB materials, you may request them from Institutional Review Board.

Please note that this letter indicates that the IRB has approved your research. You may not begin the research phase of your dissertation, however, until you have received the **Notification of Approval to Conduct Research** (which indicates that your committee and Program Chair have also approved your research proposal). Once you have received this notification by email, you may begin your data collection.

Leilani Endicott, Ph.D.
Chair, Walden University Institutional Review Board
Email: IRB@waldenu.edu
Tollfree : 800-925-3368 ext. 1210
Fax: 626-605-0472
Office address for Walden University:
155 5th Avenue South, Suite 200

CURRICULUM VITAE

Matilde Roig
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Cooper City, Fl 33026
Cell: 954-804-5407
Work Phone 954-201-7812
E-mail: matilderoig@yahoo.com

Education:
Ed.D. Program in Teacher Leadership at Walden University (2005-2008)
M.S.T. - Biology; Physiology/ Microbiology emphasis (All credits in Biology), Rutgers University.
B.S. - Biology; Chemistry/Philosophy Minor, Upsala College
Additional Graduate Courses in Education: University of Miami (EPS 439 & 544).

Administrative Experience:

July 2007 – Present Broward Community College; Associate Vice President for Career and Technical Programs

- Oversee 140+ Technical Collegewide Programs
- Monitor and assess student achievement in programs
- Establish strategies for student achievement
- Establish and assess minority achievementes
- Recruitment, retention and job placement of students
- Assist faculty development of new and existing programs
- Annual and State Report writing to Florida Dept. of Ed.
- Workforce Development
- Presentations to local and national organizations
- Supervision of collegewide grants
- Grants identification, assessment, management and writing
- Identification and development of possible new A.S. Programs. Articulation with 4-year universities and colleges for transfer of A.S students into programs.

July 2004 – June 2007 Miami-Dade College; Chair, Biology/ Health & Wellness North Campus

- Director of Title V Grant (2006 +)
- Director of USDA ARS Grant (2006)
- College-wide Natural Science Convener overseeing all science curriculum

- Responsibilities: Curriculum development, course and assessments, faculty, staff supervision and evaluations and budget management and preparation.
- Supervision of large academic department for Biological and Health and Wellness courses. (17 FT Faculty, 5 FT Staff, 16 PT Staff and over 30 Adjuncts)
- Identifying and writing of grants.
- Development of course schedules and assessment needs.
- Supervision of faculty and Laboratory areas and Wellness Center.
- Overseeing development of Science Complex and Biological Science projects at North Campus
- USDA/Lecture Research Lecture Series
- Representation and participation in campus and college-wide committees.
- Co-Chair of the Strategic Plan Technology Subcommittee.
- Collaboration with multiple institution and High Schools.

June 2003-July 2004 Northampton Community College; Dean of Allied Health & Sciences

- Supervision of all Allied Health Programs –AAS and Diploma (Radiography, Diagnostic Medical Sonography, Nursing (RN and PN), Dental Hygiene. Also supervision of Veterinary Technology and Funeral Science.
- Supervision of academic biological and chemical sciences including the AAS in Biotechnology and Chemical Technology.
- Supervision of 24 FT faculty, 6 staff members and 7 program directors, numerous adjuncts.
- Responsibilities include: Curriculum Development, New program development, program audits, course and program assessments.
- Identifying grant opportunities and assisting in grant writing.
- Development of course schedules and assessment of needs.
- Development of an assessment plan in the science, articulation of program into 4 –yr colleges and universities and high schools
- Development two new AAS program for fall 2004/05: Direct Service Provider and Diagnostic Medical Sonography Diploma Program.

August 2001-2003 Broward Community College; Department Head of Natural Science and Wellness at Central Campus

- Supervision of large natural science

- Development of faculty schedules, hiring and supervision Curriculum development and revision both in lecture and lab courses.
- Evaluation of Full-time and Adjunct Faculty and Staff,
- Identification, and writing grant opportunities, improvement of facilities, and developing and revising curriculum along with the faculty.
- Managing the Wellness Center
- Managing A.S program in Recreational Technology, Environmental Science, and Landscape Technology.
- Representation and participation in college-wide and campus committees, establishing and implementing of Institutional Effectiveness and departmental goals, and encouraging and coordination with faculty online course development.

Recognitions and Projects:

USDA Fellow (2005)
NSF Grant Reviewer for CCLI Phase I and for CCLI Phases II and III
Title V Grant (Team member for this grant)
USDA CREES Grant (2004/05)
USDA Library Gateway Grant (2006)
Rejuvelake Project at North Campus MDC
HACU Panelist and Presenter (October 2006 – 10/28-31st)
Professor of the Year (1994, 1997)
Blockbuster Endowed Teaching Chair (1998-2001)

Examples of Grants Awarded:

Miami Dade College

- Title V – 2006 (Miami Dade College) – in collaboration with other constituents – served also as Director
- USDA ARS (collaboration in writing the grant)

Northampton Community College:

- DCED Biotech 2+2+2 Grant: Participant (NCC) for Biotechnology and outreach to educator, 2004 (responsibility: Assessment of Grant)
- SAFE Grant in Nursing (Retention driven grant)

Broward Community College

- National Science Foundation Grant: "*Multidisciplinary Approach to Teaching*" ($200,000) co-authored with 4 colleagues, 1997-1999
- Broward Community College Foundation Grant Award, 1995-1996, 1998-1999.
- Technology Enhancement Fund (TEF), 1995-1996, 1996-1997

- Grant Funding for "Science for Kids" in collaboration with the other Science for Kids Coordinators, 1996.
- Staff & Professional Development Award for "The Biology Place"-an Interactive Internet Site for Students, 1996-1998.
- Academic Computing Multimedia Grant for authoring a software program in biology, 1995.

Instructional Responsibilities

1994- 1998 Broward Community College

- Curriculum development and course/program review
- Serving on department, campus and college-wide committees
- Co-Advisor for Phi Theta Kappa *Mu Mu* Chapter (Provide leadership, collaboration, scholarship and fellowship to the Governing Executive Board members and amongst over 200 Members. Provide team- building projects and experiences.
- Students Advising
- Assessment of Course Outcomes and Programs
- Development of Technological Use in Science Lecture Classrooms
- Coordinator for "Science for Kids" at BCC Central Campus
- Provide new and unique opportunities to promote science amongst middle school-age children, manage the SFK budget.
- Coordinator for the Microbiology Lab.
- Coordinator for various Departmental events.
- Author and maintenance of WEBCT Microbiology for my courses.

1990 – 1994 Miami-Dade Community College

- Curriculum development
- Course reviews
- Departmental test Development
- Student Advising
- Development of Technology Implementation Plan, Process and Pedagogy for A& P Lab Instruction
- Development of Honors A&P course (Miami-Dade Community College, 1994)
- Development of Independent Study Nutrition Course, 1993.

Teaching Awards Received:

Broward Community College:

- The Blockbuster Endowed Teaching Chair Award, 1998-2001
- Professor of the Year, 1998-1999
- Multimedia Development Award- Development lf WEBCT site in Microbiology. 1998.
- Staff Professional Development Award-Student/Instructor interaction use in Anatomy and Microbiology Lab, 1997-1998

Miami-Dade Community College

- "Students Choice Award"- Professor of the Year, 1994

National Presentations:

HACU – 2007 – Student Forum
The League for Innovation, "Technology Conference", "2003 (Milwaukee), 2000 (Orlando), 1999 (New Orleans), 1998 (Dallas). 1994 (Houston).
Northampton Community College, Center for Teaching and Learning
Presentation of Effective Teaching with technology, 2004
"Stressbusters" I and II Workshops for students on Central Campus- sponsored by *Mu Mu* Chapter, Phi Theta Kappa, 2004
Phi Theta Kappa Regional Conference, 1999 (Florida)
In-house presentation ("Science Lite Series")- BCC-Central Campus 1998-, 1999
Higher Education Regional Consortium, 1998 (Florida)
Guest speaker at the Phi Theta Kappa Induction at Broward Community College 1999.
National Science Foundation/ Higher Education Consortium, 1998 (Washington D.C)
New Faculty Orientation, 2003, 1997, 1998
Many in-house college presentations in various colleges

Professional Endeavors:

- "X-Ploring Leadership "Seminar, 2003- Present, Northampton Community College
- Authored the Starr & Taggart – The Unity and Diversity of Life, 9e Power Point Presentations,- revision (52 Chapters)(Bio-Link CD 2nd and 3rd ed)
- Authored and Developed Power Point Presentation for the Starr and Taggart; Biology- The Unity and Diversity of Life, 8th e. (52 chapter)
- Authored and Developed the Power Point Presentation for the Starr; Biology Concepts and Connections, 4th e., textbook for Brooks Cole Publishers (41 chapters) (Bio-Link CD 2nd and 3rd ed)
- Consultant for Cecie Starr- Biology Textbook reviews and editing
- Consultant for Exemplary E- Books (Yomu Corp) (Electronic Academic Books)
- Produced a Microbiology Lab Packed for student use on central campus
- Authored Critical Thinking Question for Nutrition Text (Wardlaw, 4th ed) 1993- 1994
- Text reviews for Brooks Cole Publisher and McGraw-Hill Publisher,1991-2003

Extracurricular Community Activities:

- Miami-Dade Science Fair Judge, Miami (2004-2007) (1991-1994)
- Biotechnology Summit Planning Committee, Lehigh Valley/ Pocono Mountain, 2003-2004
- Latino Leadership Health Committee, 2003-present
- Weller Health Institute Advisory Board, 2003-present
- PA Department of Education Biotechnology Curriculum Skills Competency (Level I & II) Committee, 2003-present
- Science Olympiad Judge, 2003
- Vet Tech Pet Contest Judge, 2003
- Latino Leadership Committee, 2003-present
- PTK field trips and activities; John Lloyd State Park adoption (Cleanup and removal of exotics, planting of natives,) on a monthly basis,
- Habitat for Humanity
- Broward County Science Fair Judge (1994-2003)
- Florida State Science Fair Judge, (1998)
- Involved with students in Honors Institute, field trip, and projects, which help, enhance student learning. Projects include alternatives way to teach and learn.
- Volunteer at various Broward County Schools with science demonstrations and hand-on experience with students. This included taking BCC TEA students to the schools so that they experience "science in the classroom".
- Coastal Cleanups, medical Examiner's autopsy visits, Deerfield Beach Plant and Fauna Surveys, Bonita Beach Mangroves and Bays,. Key Largo Seacamp Weekend and Lecture Series

Member of various professional associations.
Professional science research in pharmaceutical industry.