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Gender, Mathematics, Reading Comprehension and Science Reasoning as Predictors of Science Achievement Among African-American Students at a Historical Black College or University

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GENDER, MATHEMATICS, READING COMPREHENSION AND SCIENCE REASONING AS PREDICTORS OF SCIENCE ACHIEVEMENT AMONG AFRICAN-AMERICAN STUDENTS AT A HISTORICAL BLACK COLLEGE OR UNIVERSITY

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Abstract of a Dissertation
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ABSTRACT

GENDER, MATHEMATICS, READING COMPREHENSION AND SCIENCE REASONING AS PREDICTORS OF SCIENCE ACHIEVEMENT AMONG AFRICAN-AMERICAN STUDENTS AT A HISTORICAL BLACK COLLEGE OR UNIVERSITY

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This study investigated predictors that influence the science achievement of African-American non-science majors in a Physical Science class. The population consisted of male and female college students enrolled in Physical Science courses at a historical black college or university (HBCU) located in the southeastern portion of the United States. A personal data information sheet was administered to 120 participants during the Fall of 2008. The personal data information sheet consisted of questions pertaining to the high school courses, students took in math, language arts and science. It also consisted of basic background information. Students also gave written consent for their midterm and final grades earned in Physical Science to be used in the study as part of the analyses. A t-Test including chi-square tests revealed that there was not a significant difference in the raw scores of African-American females and African American males on the American College Test. A significant difference was not observed between the females and males on the ACT math subtest, t (118) = -.78, p=.43; reading comprehension subtest, t (118) = -1.44, p= .15 or on the science reasoning subtest, t (118) = -1.46, p=.15. A significant difference was not found between the final grades of African American females and the final grades of African American males. Chi-square

tests were conducted to determine goodness of fit, X^2=6.11, *df* = 1, p= .191. Although the grades of females were higher than males, results were not significant. The correlation between math ACT and final grades were not significant, r = .131, N=120, p = .155, reading comprehension ACT and final grades were not significant, r = .072, N=120, p = .434 and science reasoning ACT and final grades were found not to be significant, r = .109, N = 120, p = .237. Being that the majority of students who participated in the study were from one state, had similar high school backgrounds, had similar majors and were similar in age the sample had more homogeneity than difference. This may be the most plausible explanation for the results found in this study.

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CHAPTER I

INTRODUCTION

The Importance of Science

The world today would be quite different without the influence of science. The knowledge of science helps us better understand the world around us. Many products that are most desired by children would not exist without science innovations. Innovations in science have dictated how we feel society should function. Just as the invention of the telephone, a cure for small pox, and the automobile changed the world in the past century; so has more recent advances such as the cellular telephone, gene therapy, and automobiles that use the power of corn rather than petroleum for fuel.

Furthermore, science encourages us to find solutions to our own problems by making observations, forming hypotheses, analyzing data, conducting experiments, communicating and drawing conclusions based on each individual investigation. All of the aforementioned innovations would not exist without skills used and enhanced from the knowledge of science.

Geary and Hamson (2007) reported that a low level of science achievement is detrimental to success in life. They reported that success in science and math could have strong economic and societal consequences. Moreover, students who have high achievement in science and math could improve their chances of being employed and receiving higher wages.

In a recent demographic study about how America can build a better future, the significance of knowledge gaps of non-Caucasians in comparison to their Caucasian counterparts was listed as a cause of economic hardships and inequality in America.

Fewer resources and less qualified teachers were also listed as detriments to the problem (Alliance for Excellent Education, 2006).

High school graduation rates have declined among all races. Recent polls reported that out of all students, 70 percent actually graduate in the United States from high school. Although minorities make up a small portion of the total population included in the majority of schools in the United States, only 52 percent of the total population of Hispanic students enrolled in high school actually graduate. Also, only 56 percent of the total number of all African-American students enrolled in high school actually graduate. In addition, 57 percent of the total number of all Native American students go on to graduate high school (Alliance for Excellent Education, 2006). Of those that graduate among African Americans, Hispanics and Native Americans; an even greater number fall behind and do not graduate with their perspective classes. Many students who fall behind do not go on to attend college. As the American minority population grows, the graduation rates for minorities steadily decline. This decline has also caused the United States to suffer. This suffering is largely because the economy is dependent on new high school students who are knowledgeable to help strengthen its economic standing in the world (Alliance for Excellent Education, 2006).

The Government and Science in the 20th Century

In the mid 1940's President Franklin D. Roosevelt wrote a letter to Vannedevar Bush, the director of the Office of Scientific Research and Development, asking Bush how the experiences brought about during World War II could be used to foster enterprise and the American way of life after the war. Bush responded by writing, *Science the Endless Frontier* (1945) which was an optimistic belief in the positive outcomes of investment in scientific advancement to improve the health of humans and to improve security measures in the United States. This report became landmark and the government itself became a patron in the advancement of science (Magner, 2002).

Statement of the Problem

In a society driven by science and technology, many high school and college graduates have been reported as unknowledgeable about basic scientific concepts (Lee, 2002). The issue of science literacy has been the primary focus of Project 2061. Project 2061 is an initiative of the American Association for the Advancement of Science (AAAS) aimed at promoting science literacy in math, technology and science by the year 2061. The year 2061 was chosen because this is the projected year that Halley's Comet will return to earth. The Project 2061 initiative began in 1985.

Project 2061 efforts were catapulted by the release of the report, "Science for All Americans", published in 1989. This report highlighted in detail the science performance and achievement of American school age children in comparison to their school age counterparts in other countries. School age children of the same grade level, from various countries, including the United States, were given the same test on the same science content. The results indicated a remarkable deficit among school age children from the United States in comparison to students from other countries. Following this, the ground work for standard based teaching and the Benchmarks for Science Literacy were incorporated into established goals for the promotion of science literacy in the United States. Furthermore, each state developed its own curriculum based on the benchmarks (AAAS, 2007).

The No Child Left Behind Act (NCLBA) in 2001 forced many districts to revisit their own individual instructional strategies. Emphasis on test scores and achievement in science courses became a major focus. Previous research has shown that the development of science literacy is related to student achievement (Moore & Foy, 1998). A student's failure at school has been associated with later issues with substance abuse, violence and acts of criminal behavior (Goodstadt, 1989). Moreover, a student's failure in science courses and science related courses has been associated with low socio-economic status, low potential for employability and lower wages once employed (Geary & Hamson, 2007).

Purpose

The purpose of this research was to collect data that could help identify some of the factors that influence African-American achievement in science. The research population included students who were not science majors and enrolled in a Physical Science course at a historical black college or university. The results of this research could enable science educators and researchers to design programs that will build the reading comprehension, science reasoning and mathematic skills of college level students. The improvement of these skills would help students succeed in science as well as graduate school programs.

Theoretical Framework

The focus of this paper was based on the assumption that a person's achievement in science and science related courses can be attributed to several factors. These factors included: individual achievement in mathematics, ability to reason scientifically, ability to comprehend written language, ability to comprehend spoken language, and the gender of the individual.

Many studies have focused on the importance of science achievement (Beaton et al., 1996; Geary & Hamson, 2007; Harding et al., 1995; Mullis et al., 1998; Von Secker & Lissitz, 1999). The United States has been deemed as one of the wealthiest nations in the world however, when it comes to science achievement, it is ranked very low when compared to other nations (Beaton et al., 1996; Forgione Jr., 1998; Geary & Hamson, 2007; Linn et al., 2000). In recent studies, United States 8^{th} graders ranked 28^{th} out of 41 nations (Geary & Hamson, 2007). Seventh graders, ranked 24^{th} out of 39 nations (Geary & Hamson, 2007). Although the United States as a whole has performed poorly in science when compared to other nations; African American students tend to have more difficulty when compared to their Caucasian counterparts (AAAS, 2007; Alliance for Excellent Education, 2006; Ikpa, 2003; Jencks & Phillips, 1998; Lucas, 2000; Trent, 1997).

Previous literature argued that because equal opportunity to public education has been given to Caucasians as well as minorities an inadequacy in achievement must be the result of one of three factors. These factors include cultural practices, lack of desire to achieve and other inherent factors such as genes and environment (Hernstein & Murray, 1994; Thernstrom & Thernstrom, 2003). In contrast, the literature has also linked the difficulties that African Americans face to the disparity in resources within the community to improve the science and other related skills of not only African Americans but other minorities as well (Darling-Hammond, 1998; Ikpa, 2003; Johnson & Kritsonis, 2006).

The disparity in resources often limited or in some cases nonexistent in communities that largely service minorities are a lack of qualified teachers, materials, inadequate curriculum and curriculum resources (Darling-Hammond, 1998). According to the Trends In Mathematics and Science Study (TIMSS), fifty-five percent of science teachers in the United States are not knowledgeable about the field in which they teach due to a lack of a major or minor in a science subject area (Forgione Jr., 1998).

Recent literature cited the United States as the most unequal industrialized country in the world with race as a factor attributing to the different opportunities for learning. The United States differs from European and Asian countries because it bases opportunities on social class as well as race. Access to quality education was also associated with access to funding opportunities to support education (Darling-Hammond, 1998; Kozol, 1991).

Recent polls reported that minorities heavily reside in states in which the average household income is $48,371.30. These states included: Alabama, Arizona, Arkansas, Alaska, California, Georgia, Florida, Hawaii, Illinois, Louisiana, Massachusetts, Maryland, Michigan, Mississippi, New Mexico, North Carolina, New Jersey, Oklahoma, South Carolina, Texas, Utah, Virginia, and Washington, (United States Census Bureau, 2006; Williams, Morris & Furman, 2007). States with low minority populations had an average household income of $101,267.46 which was 2.09 times greater than the average household income of states in which minorities heavily resided. The states with low populations of minorities included: Colorado, Connecticut, Delaware, Idaho, Indiana, Iowa, Kansas, Kentucky, Maine, Minnesota, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode

Island, South Dakota, Tennessee, Vermont, West Virginia, Wisconsin, and Wyoming. This difference in the overall average household income caused many minorities to be totally or partially dependent on financial aid, grants and scholarships in which resources are limited or simply not available (United States Census Bureau, 2007; Williams, Morris, & Furman, 2007). In addition, research has also shown that many minorities do not tend to leave their home state to pursue academic education in institutes of higher learning due to economic constraints (Guess, 2007; Williams, Morris, & Furman, 2007).

According to a recent article the need for math and science achievement was cited as imperative for the United States to remain a fierce competitor in the global market (Alliance for Excellent Education, 2006; Geary & Hamson, 2007). The strength of the economy is based on skills that students obtain in math and science courses. Having skills in science and math increases the employability of an individual and gives that individual an socioeconomic advantage in a technologically driven society (Alliance for Excellent Education, 2006; Center for Public Education, 2007; Geary & Hamson, 2007).

The United States Commission on National Security listed math and science achievement deficiencies as a greater threat to the security of the Unites States than any war we have ever seen or could possibly conceive (NCEE, A Nation at Risk, 1983). To remain fierce competitors in the global market, investment in the future of American students is critical. American students would include all of the races represented in the United States population and both genders (Center for Public Education, 2007).

Many studies have focused on math achievement (Beaton et al., 1996; Ding & Davison, 2005; Lee, 2006; Marsh, 1986) and science achievement (Beaton et al., 1996; Harding & Parker, 1995; Mullis et al., 1998; Von Secker & Lissitz, 1999). These studies concluded that learning is a process that can be enhanced over time and that achievement levels in math and science could improve.

The Trends In Mathematics and Science Study (TIMSS) is a four year cycle international study that began in 1995 and has been repeated every four years since its initial launching. The last cycle was completed in 2007. TIMSS was developed by the International Association for the Evaluation of Educational Achievement (IEA). The assessment includes the science and mathematics content of 4th and 8th grade students by using benchmarks that are universally defined. The 4th grade assessment includes all of the science and mathematics knowledge prior to and including 4th grade. The eighth grade and the last year of high school are also assessed. The study began with forty-one nations participating and has since in recent studies added an additional 19 participating countries totaling 60 countries. These countries included: Algeria, Armenia, Australia, Austria, Bahrain, Bosnia and Herzegovina, Botswana, Bulgaria, Canada, Chinese Taipei, Colombia, Cyprus, Czech Republic, Denmark, Djibouti, Egypt, El Salvador, England, Georgia, Germany, Honduras, Hong Kong, Hungary, Indonesia, Iran, Israel, Italy, Japan, Jordan, Kuwait, Latvia, Lebanon, Lithuania, Malaysia, Malta, Mongolia, Morocco, Netherlands, New Zealand, Norway, Palestinian National Authority, Qatar, Romania, Russian Federation, Saudi Arabia, Scotland, Serbia, Singapore, Slovakia, Slovenia, South Africa, South Korea, Sweden, Syrian Arab Republic, Thailand, Tunisia , Turkey, Ukraine, United States and Uzbekistan. Unlike other countries, TIMSS research in the United States is conducted by the National Center for Education Statistics, an entity of the United States Department of Education (USDE).

Assessment is conducted in two parts. The first part consists of questionnaires that are given to the students, teachers, and schools. The student questionnaire asks questions regarding the student's attitude, perception, experiences at school in general and in the classroom as well as background information including the student's demographic information. The teacher and school questionnaire asks questions about the mathematics classes offered, science classes offered, student schedules, the educational level of the teacher, teacher opportunities for professional development, school policies and procedures, and resources available for the student and teacher. The second part of the assessment includes the actual test that is administered to each student. This test includes questions that range from minimum to increasing difficulty. TIMSS tests the math and science curriculum of schools around the world and whether or not the math and science curriculum taught actually works. Whether or not a curriculum works is based on the achievement level of students who participate in the study.

The Progress in Reading Literacy Study (PIRLS) is a five year cycle international study that began in 2001 that uses benchmarks for reading literacy assessment that are universally defined. PIRLS was also developed by the IEA and is considered to be one of the largest studies on reading literacy ever conducted. The study was also repeated in 2006 which will conclude in 2010. The emphasized target areas of literacy include: process of comprehension, purposes of reading and reading behaviors and attitudes. It focuses on the reading literacy of 4^{th} graders from 35 various countries. These countries included: Argentina, Belize, Bulgaria, Canada, Columbia, Cyprus, Czech Republic, England, France, Germany, Greece, Hong Kong, Hungary, Iceland, Iran, Israel, Italy, Kuwait, Latvia, Lithuania, Macedonia, Moldova, Morocco, Netherlands, New Zealand, Norway, Romania, Russian Federation, Scotland, Singapore, Slovak Republic, Slovenia, Sweden, Turkey and the United States (Beaton et al., 1996).

Assessment in PIRLS is conducted in two parts, student testing and through information reported on multiple questionnaires. Assessment involves obtaining information from the students as well as the students' home and parents, teachers and the school the student attends. Students on the questionnaire were asked to answer questions regarding self esteem, perceptions and instructional experiences and access to literacy resources. Parents were asked to answer questions about demographics and socioeconomic status and their child's reading experiences encountered at an early age. Schools were asked to answer questions about enrollment, staffing, reading literacy resources as well as other resources to support reading programs within the school. Teachers were asked to answer questions involving instructional strategies, classroom resource materials, his/her educational background and professional development. In addition, students were administered a written test that included the interpretation of various reading passages on the fore-mentioned emphasized target areas. This study gives educators, schools and policy makers valuable information in the planning of school based initiatives in the promotion of reading literacy and instruction coupled with the opportunity to see how current methods compare to other countries in the world (House, 2003; Topping & Ferguson, 2005).

Hypotheses

The research conducted in this paper addressed the following hypotheses:

1. There would be a significant difference in the raw scores of African-American females in comparison to African-American males on the American College Test subtests.
2. There would be a significant difference in the final grades of African-American females in comparison to African-American males earned in Physical Science courses.
3. The subscores of African-American students on the reading comprehension, mathematical skills and science reasoning portions of the American College Test would positively correlate with each student's individual Physical Science final grade.

Assumptions

The study was based on the following assumptions:

1. African-American students that participated in the study were comparable to African-American students at another historical black college or university.
2. The American College Test scores for African-American college students were appropriate for this study.
3. The American College Test scores used were accurate and untainted.

Delimitations

The study consisted of the following delimitations:

1. The study was limited to students enrolled in Physical Science. In addition, the study was limited to the outline designated by the university.

2. This course was taught in a classroom setting at a historical black college or university in the southeastern portion of the United States.
3. The study was limited to African-American students not majoring in science or science-related disciplines.

Definition of Terms

American College Test (ACT): a multiple choice achievement test used by many colleges as part of the entrance requirements for prospective students. The ACT consists of four parts. These parts include: English, Mathematics, Reading and Science Reasoning.

Benchmarks for Science Literacy: an educational guide that accompanied the report, Science for All Americans (AAAS, 2007) that suggests how one might obtain a functional level of science knowledge by adulthood.

Curriculum Resources: materials used to provide an understanding of planned lessons within a designated curriculum. Resources may include, but are not limited to: guided reading activities, manipulatives, laboratory equipment, computers, guest speakers, and textbooks.

Historical(ly) Black College or University (HBCU): a college or university whose history, traditions and cultural beliefs are primarily based on the African-American experience. Historical Black College or Universities intent and focus is the promotion of academic excellence of African-American men and women.

International Association for the Evaluation of Educational Achievement (IEA): an association of educational researchers, research institutions and government agencies whose purpose is to conduct studies in the field of education and educational research.

Knowledge Gap: deficit in the knowledge of a subject matter that diminishes the level of understanding that a person embodies.

Mathematical Achievement: the ability to grasp mathematical concepts with ease and perform well on graded assignments involving measurements, properties and relationships of quantities expressed by numbers and symbols .

National Center for Education Statistics: an entity of the United States Department of Education that gathers, interprets and publishes statistical data on education, schools and compares these statistics to that of other countries.

No Child Left Behind Act 2001(NCLBA): legislation designed to ensure that all students receive an adequate education introduced during the presidency of President George W. Bush.

Physical Science: is science that concerns itself with making sense of the natural environment and how human beings interact within the environment.

Progress in International Reading Literacy Study (PIRLS): the largest international_study of the trends in reading literacy achievement. It compares the reading literacy achievement of 4^{th} graders from 35 different countries.

Project 2061: an initiative began by the American Association for the Advancement of Science (AAAS) to promote science literacy in American schools. The initiative began in 1985 and has the goal year to meet expectations of a science literate America by the future year 2061, the projected year Halley's Comet will return.

Quality Education: education that adequately prepares a student to be a functional member of society with a collective body of academic knowledge.

Qualified Teachers: teachers who are well versed and knowledgeable about the discipline in which they teach and the applications of the subject contents

Quantitative Research: explores the relationship among mathematical models to explain natural phenomena and is often expressed numerically.

Reading Comprehension: the ability of an individual to apply meaning or understanding to written material.

Science Achievement: the ability to successfully grasp scientific concepts and their applications and to reason scientifically with ease and perform well on graded assignments.

Science Literacy: having a functional level of scientific knowledge and ability to incorporate the basic science process skills such as: observation, communication classification, measurement, inference and prediction to everyday life.

Science Performance: the action of studying science concepts and their applications.

Science (Scientific) Reasoning: the ability to think logically and make inductions and deductions regarding scientific ideas and concepts.

Significant: the outcome is not due to chance alone.

Trends in International Mathematics and Science Study (TIMSS): a study designed to compare the performance level of school age children internationally in science and mathematics. This study was formerly known as the Third International Mathematics and Science Study.

Justification of Study

According to TIMSS, research must continue to improve the mathematics and science achievement of students around the world. TIMSS collects information that includes instructional procedures, content and performance of students over a four-year cycle. Instructional strategies can then be amended or new ones implemented in an effort to improve the performance of students (TIMSS, 2007). Countries including the United States, have made the connection between the relevance of science achievement, employability and economic competitiveness in the global marketplace. The economy is dependent on new high school students who are scientifically knowledgeable to strengthen its economic standing in the world (Alliance for Excellent Education, 2006). In addition, Geary and Hamson (2007) reported that achievement in science is related to success in life and has strong economic and societal consequences (Geary & Hamson, 2007).

Lack of achievement in science and math impacts the future of African Americans. As the population of the United States increases, the graduation rates of minorities steadily decline (Alliance for Excellent Education, 2006). The ability to understand and improve science achievement would therefore increase the presence of African Americans in the fields of science and technology (Williams, 2008).

The American College Test takes into consideration that students who take the exam understand: the basics of word mechanics and punctuation, can read and write, can comprehend what they have read, are able to express themselves in writing, have a functional level of logistical and mathematic skills and can think and reason scientifically. These are all skills that the learner should have acquired prior to entrance into college (Barrons Regents, 2008).

Many standardized tests have worked on doing away with gender bias. However, studies have shown that females outperform males in science reading. The same study shows that males outperform females in hands-on science activities (Halpern et al., 2007). In addition to these findings, a recent study found that the science achievement of boys have declined from grade school to college with age since 1996 (Mead, 2006). Girls have higher grades when compared to boys with similar academic abilities. Boys are also less likely to attend and graduate from college based on recent reports (Chicago News Office, 2006).

The comprehension of written material has been linked to the ability of the individual to assimilate prior knowledge with new knowledge. Through trial and error the learner is able to construct knowledge through assimilation and accommodation (Piaget, 1950). Without the knowledge of textual schemes a reader can misinterpret meaning (Kitaeo, 1990). Reading comprehension is important to achievement in science because the ability to process science depends on interpretation of data, the ability to reason, to understand what is implied and to follow methods and procedures.

Literacy reform is one of the top priorities of the United States Department of Education. According to recent studies, the value of reading comprehension is beyond measure. Adult literacy has been linked to poverty. Forty-three percent of adults who receive welfare benefits are not functionally literate. Being illiterate has also been connected to societal ills such as drugs and violence. Therefore, investigating reading comprehension and ways to improve reading skills would be very beneficial to our current understanding (Alliance for Excellent Education, 2007; Center for Public Education, 2007; Geary & Hamson, 2007).

Although reading ability is measured by vocabulary and comprehension, performance in courses that incorporate methodology, such as science, reading comprehension makes the largest contribution toward performance (Onwuegbuzie, 2004).

According to Bill Tillery (2006), the study of Physical Science provides a chance for individuals to gain reasoning skills. It also helps individuals to become better acquainted with the environment in which they are apart of. Because non-science majors are limited in their scientific knowledge, they are ideal for the study of whether or not instructional models using constructivism can not only enhance performance but help students achieve in science (Tillery, 2006).

The Relevance of the Global Marketplace

In the last couple of years the economy of the United States has suffered a substantial blow. To remain economically competitive, requires the knowledge of understanding the strengths and weaknesses that undergird the country. The literature itself attributes the success of this country on the wealth of diversity within the United States and knowing where or with who these strengths remain. Science achievement according to Geary and Hamson is detrimental to success in life and helps provide a positive basis for economic competitiveness in the global marketplace (Geary & Hamson, 2007). The findings of this research could provide information regarding the role that gender has, if any, in science achievement in a Physical Science class at a HBCU. If gender is found to be positively correlated with science achievement, learning strategies can be implemented on all academic levels (from preschool and beyond) to provide opportunities for males and females to interact in classroom activities and assignments. One way of doing this is through cooperative learning groups that take into account the equality of the ratio of male to female. If males are better in hands on science activities and females are better at deriving at methods of explaining how a finding from the science activities occurred; both male and females can benefit from each other's strengths.

If mathematics skills are positively correlated to science achievement in a Physical Science course at a HBCU, this could indicate a need for remedial courses or university designated math courses as prerequisites to Physical Science.

If science reasoning is positively correlated to science achievement in a Physical Science course at a HBCU, this could indicate a need for courses that teach inductive thinking skills, field studies such as a trip to the Barrier Islands to explore natural diversity or in depth investigations at local zoological parks and exploration of local geological treasures. The key concept is exploration through hands on activities that broadens the individual or student and provides exposure to opportunities for new scientific learning. Courses such as State Geology or Applications in Field Biology could be added to the current course offerings. Current, clear and reader friendly textbooks in science could also be added to the university or college library.

If reading comprehension is found to be positively correlated to science achievement in a Physical Science course at a HBCU, this could indicate a need for the reading levels of students to be assessed prior to taking the Physical Science course. If reading deficits are identified through assessment, the student's enrollment in Physical Science would be delayed until the successful passing of the reading remediation program. Comprehension of basic science concepts are based on successful reading ability. Thus, science literacy can not take place, if such deficits are not addressed.

The promotion of global competitiveness through science literacy depends on identifying those factors that are positively affecting science achievement in Physical Science courses at historical black universities or colleges. Therefore the results of this research will provide information that will enhance scientific knowledge and improve both science literacy and science achievement. The findings of this research could also help diminish gender bias in science, increase the presence of African Americans in science careers and emphasize the importance of steadfast mentoring, tutoring and educating of African Americans regarding possible career choices in science and science-related disciplines.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

African Americans and Achievement in Mathematics

According to TIMSS, students within the United States are far behind students in other countries who are technologically advanced. Being that these countries are more technologically advanced, mathematics scores are much higher than that of the United States. Possible reasons for the United States falling behind other countries include: lack of knowledgeable teachers, teachers not using creativity in their practice, and textbooks that are not clear or are poorly constructed (Yore, Shymansky, Henriques, Chidsey, & Lewis, 1987).

Improving the academic experiences for African Americans improves the opportunity for African Americans to have a better future. According to recent reports, African Americans males account for a large percentage of the criminal justice system (Ladson-Billings, 1997). Even more alarming, according to the literature, is the fact that more African American men are incarcerated than in institutes of higher learning (Ladson-Billings, 1997).

During the early 1990's, African Americans made significant mathematics achievement that narrowed the gap between their white counterparts. However, this gap began to widen again- halting progress in the 1990s in the area of mathematics achievement and has continued to widen. Studying the gaps in achievement helps researchers learn more about which students are adequately prepared for college. Suggestions from the National Council Teachers of Mathematics cite instructional practices in the way Caucasian students are taught math content versus how African American students are taught as a contributing factor (The Education Trust, 2003).

Access to quality resources and school segregation continue to be factors in influencing the instructional practice of mathematics. More Caucasians are receiving standards-based education from kindergarten through 12th grade. The difference in instructional practice according to recent studies had very little to do with socioeconomic status but everything to do with race. In addition to instructional practices, teacher expectations are different based on race and gender. African American children are often underrepresented in gifted programs. In order for students to be included in gifted classes, the student must pass a performance-based assessment based on Howard Gardner's Theory of Multiple Intelligences. These test are often biased and do not reflect subject matter of a multicultural design but that of Caucasians (Johnson & Kritsonis, 2006).

Qualified teachers are few in number in schools where minority populations are large. Therefore, African American are less likely to be taught mathematics by teachers with a firm sense of pedagogy and knowledge of mathematics. Modern day mathematics is also aided by computers. Often schools with high numbers of African Americans and other minorities do not have access to computers or enough computers for each student to benefit from the instruction (Johnson & Kritsonis, 2006).

African-Americans face difficulties receiving their bachelors' degrees in math and science. Reasons cited by the American Council on Education include financial difficulties and lack of preparation (Weissman, 2006). Moreover, academic achievement was identified as a barrier and issue of the poor and those that were powerless (Ikpa, 2003).

The literature itself states that the dropout rate for African Americans urban, inner city youth is increasing (Ladson-Billings, 1997). Although having a high school diploma does not provide anyone a secure future, without the diploma it is almost impossible. According to Bob Moses, a well-recognized activist in the civil rights movement, mathematics literacy is crucial to success in life. He also stated that African Americans do themselves an injustice by choosing to opt out of algebra and other higher level mathematics courses (Ladson-Billings, 1997). Recent reports also confirm that many African American high school students do not understand the relevant implications of mathematics (Walker, 2007). According to a study conducted by Clewell et al. (1992), several factors outline the attitudes of African Americans toward math. These factors include: math not being seen as helpful in their chosen career choices, math is too difficult and time consuming and mathematics achievement may cause one to be socially unacceptable or viewed as a nerd (Clewell, Anderson, & Thorpe, 1992).

African Americans and Achievement in Reading Comprehension

Literacy continues to be a major factor in the education of American children, particularly African Americans. According to A. W. Tatum (2000), literacy achievement for African Americans has been a direct result of misconceptions of African Americans by educators, economic hardship and being isolated as a culture.

The 1999 administration of the National Assessment of Education Progress (NAEP) reported that African Americans are at risk for reading failure. NAEP also reported that African Americans reading ability on the 1999 assessment score was an average 27%. Caucasians in the same assessment scored an average 63%. This is alarming in the fact that the ability to read well is essential to comprehension in key subject areas such as, science, math, and geography. According to the No Child Left Behind Act of 2001, students in the United States are required to be able to read by grade 3. This presents a major challenge to educate African American children, who, in many instances, have already fallen behind (Craig, Connor, & Washington, 2003).

Before an individual can comprehend written material, the individual must first be able to read. The passing of the National Literacy Act of 1991, further shed light on our nation's literacy problem. "In its 1991 National Literacy Act, Congress defined literacy as a person's ability to read, to write , and to speak in English, and to compute and solve problems at levels of competence necessary to function both on the job and in society, to accomplish one's goals , and to recognize one's own knowledge and potential" (Onwuegbuzie, 2004).

Recent studies suggest that the needs for African Americans to achieve literacy are different than their Caucasian counterparts (Levine & Eubanks, 1990). Also, studies show that African Americans lag far behind Caucasians in reading achievement in both the primary and secondary grade school levels. African Americans have been recorded as having the lowest completion rates, in comparison to other minorities, in institutes of higher learning. In addition, the instructional practices of teachers impede the literacy and reading comprehension of African Americans (Gehring, 2001).

Being that reading and writing are both thought processes, grammatical rules which are important to reading comprehension must began to take into consideration the sociocultural background of individuals in the development of reading materials. Theories involving schema affirm that reading comprehension is a result of the environment and personal experiences of an individual. Therefore, written material that is culturally unfamiliar can cause major gaps in the reading comprehension of African Americans (Onwuegbuzie, 2004). Researchers have found that African Americans speak a language that has developed from a mixture of standard English and African language. This language is called, Ebonics. Instruction in Ebonics describes the bilingual teaching of language and reading acquisition from an African American cultural view (Perry & Delpit,1998). However, the teaching of Ebonics remains to be mainstreamed into the national curriculum standards and instructional practices. It should also be noted that every African American does not speak Ebonics.

African Americans and the Ability to Reason Scientifically

The lack of achievement of African Americans in science is well documented. However, a full-proof plan for increasing the academic achievement of African Americans in science has proven to be a challenge. A factor that hinders the achievement of African Americans, according to recent studies, is the ability to reason scientifically (Chapell & Overton, 2002). Scientific reasoning incorporates inquiry-based learning and both inductive and deductive reasoning skills (Chapell & Overton, 2002).

Scientific reasoning involves using your five senses as well as personal experiences (Rezba et al., 2003). African Americans have been reported to have limited experiences to provide a means of forming scientific conclusions. These limited experiences may be the result of socioeconomic status, ethnic identity or self esteem (Chapell & Overton, 2002). Being able to reason has been identified as a result of an individual's ability to construct scientific prior knowledge with new information. Scientific knowledge can be enhanced by vicarious experiences such as museums and outdoor explorations (Gerber, Cavallo, & Marek, 2001).

Studies of African American reasoning ability on various performance tasks at grades 6, 10 and 12, showed increased ability in deductive reasoning skills. This increased ability mirrored the pattern of scientific reasoning skills for Caucasians in the same age groups. Other studies have shown that the context of material, parenting styles and test anxiety may influence the overall reasoning abilities of African Americans (Chapell & Overton, 2002).

According to recent literature, African Americans do not perform well on tests that require the use of cognitive skills. This has been related to ethnic differences attributed to intelligence, cultural differences and linguistic skills (Jencks & Phillips, 1998; Neisser et al., 1996). However, according to Ogbu (1986), African Americans posess the same intellectual capacity and cognitive skills, such as the ability to reason logically, as Caucasians (Ogbu, 1986).

African Americans have not always been given the opportunities to work in jobs that require strong cognitive abilities. African Americans continue to comprise the majority of "blue collar" jobs. This is largely because African Americans still lag behind Caucasians in academic opportunities and educational experiences that lead to "white collar" and lucrative positions in the global marketplace (NSF, 2008). The literature also shows that African Americans tend to be more acceptant of their identity within the workforce and do not cross cultural or cognitive boundaries. Also, African Americans do not exemplify behaviors that lead to cognitive performance such as taking challenging courses and high achievement on tests for fear of "acting white" (Ogbu, 1986). Jencks and Phillips reported that previous research has shown African Americans exemplify many negative behaviors toward cognitive performance due to many years of racial oppression (Jencks & Phillips, 1998).

The challenge then for science educators is to provide opportunities for learning cognitive skills through creative instructional strategies that go beyond the traditional classroom. Making use of resources, according to recent studies may be in the form of social interaction with peers. Reasoning can also be encouraged through inquiry-based learning, parental involvement, laboratory activities, the number of books a student has at home and any activity outside the classroom that fosters learning. This holds true for African Americans and any other race of individuals (Gerber, Cavallo, & Marek, 2001).

African Americans with Bachelors Degrees in the Physical Sciences

The representation of African Americans in Physical Science has steadily declined in recent years in comparison to other fields of science at historical black colleges or universities (HBCU). According to reports from the National Science Foundation (May, 2008), bachelors degrees have increased in Agricultural Sciences, Biological Sciences, and Computer Sciences at HBCUs, with the exception of Physical Science. African Americans earned approximately twice as many Physical Science degrees at Predominately White Institutions (PWIs) than HBCUs. However, African Americans showed very little increase in degrees awarded in Physical Science when compared to Agricultural, Computer and Biological Sciences from the years 1995-2004.

African Americans with Graduate Degrees in the Physical Sciences

Current data reveals that 283,466 masters degrees were awarded to women in science from 1996-2005. It was also noted that of the 283,466 women receiving master's degrees in science, 10.92% were awarded to African-American women. Simultaneously, of the 283,466 masters' degrees awarded, 8,491 women were awarded degrees in Physical Science and of the 8,491 degrees that were awarded, 6.218% were awarded to African American women in Physical Science (NSF, 2008).

Employed scientists and engineers with masters' degrees were equivalent to 1,003,600 in 2003. Out of the total of employed scientists and engineers, 38.01% were females and 61.99% were males. African Americans employed as scientists and engineers with masters' degrees totaled 5.82% women and 3.15% men. At the doctorate level, there were 488,300 United States citizens employed as scientists and engineers in 2003 of which 31.44% were females and 68.56% were men. African American females totaled .20% and African American men made up the .33% of the employed scientists and engineers in 2003 (NSF, 2008).

According to demographic studies conducted by the National Science Foundation (2006) based on age, men of all races 50 and older with a doctorate degree in science and engineering employment rate doubled in comparison to women of the same age group. In addition, 40-49 year old men with science and engineering doctorates, doubled the number of women doctorates employed in all races represented within the same age group. In the 30-39 age group, Caucasian, Asian and Hispanic men approximately doubled the number of women in the same age group employed with science and engineering doctorates. However, African American women and American Indian and Alaskan Native women outnumbered the men employed with science and engineering doctorates. Age 29 and younger had a greater representation of women of all races employed as scientists and engineers with doctoral degrees (NSF, 2008).

In a demographic study in 2003 on science and engineering doctorates employed at four-year colleges and universities as faculty members, revealed 267,100 female science educators within the United States of which 2.321% were African-American women. Men represented 180,000 of the total number of science educators in the United States of which 2.889% were African American. Women who were Physical Science faculty members numbered 41,900, of which .4773 were African American. Men who were Physical Science faculty members numbered 35,400, of which 1.130% were African American (NSF, 2008).

Between 1998 and 2005, doctorates awarded to United States citizens and permanent residents in science and engineering totaled 132,304. Of the doctorates received, 3.679% were awarded to African Americans. African American women, during the same years, received 2.152% doctoral degrees. For the period of 1998 through 2005 the number of doctoral degrees awarded to United States citizens and permanent residents in Physical Science totaled 16,446 of which 2.888% were received by African American men and 1.155% received by African American women (NSF, 2008).

Earning Potential of Science and Engineering Graduate Students

According to the National Science Foundation, the median annual salary of employed full time scientists and engineers by the year 2003, including both genders, were from greatest to least: Caucasians who earned approximately $60,600, Asians who earned approximately $60,000, American Indian and Alaskan Natives who earned approximately $60,000, African Americans who earned approximately $53,500 and Hispanics who earned the least, approximately $47,000 (NSF, 2008).

Asian women who were physical scientists earned approximately $50,000. African American women earned approximately $50,000. Caucasian women earned approximately $48,000. American Indian and Alaskan Native women earned approximately $47,000 and Hispanic women earned the least, $42,000 (NSF, 2008).

In consideration to the median annual salary of men working as physical scientists in 2003, Caucasian men earned the highest median annual salary, earning approximately $65, 500. Asian men earned approximately, $64,000. American Indian and Alaskan Native men earned approximately $60,000. African American men earned approximately $55,400. Hispanic men earned the least with a median annual salary of $50,000 (NSF, 2008).

Because the economic strength of the United States is based on its best resource, the citizens, investing in science education would yield a good return. Investing in science education would include investing more monies into the public education system to attract others outside the field of education to become science educators. Technology has influenced the development of many professions as well as literacy. Understanding technology and its influences on science is essential for success in science and the world. To compete in the global marketplace an individual must be a part of a Learning Society. This is where learning takes place outside of the traditional schools, colleges and universities and extends to the work environment and through networking opportunities with other people in and outside of your discipline (USDE, A Nation at Risk, 1983).

Some researchers believe that the United States has failed at the Sputnik challenge. The Sputnik challenge refers to the competition between the United States and the Union of Soviet Socialist Republic (USSR) in space exploration. Many mark the landing of the USSR's Sputnik as a landmark achievement in science because this meant that the Russians were more scientifically and technologically advanced being that they were the first to launch an artificial satellite into outer space (NASA, 2007).

The perceived failure at the Sputnik challenge was indicated by the following: "Some 23 million American adults are functionally illiterate by the simple everyday tests of reading writing and comprehension; About 13 percent of all 17-year olds in the United States can not be considered functionally literate; Average achievement of high school students on standardized tests is now lower than 26 years ago when Sputnik was launched; The College Board's Scholastic Aptitude Test (SAT) demonstrate a virtually unbroken decline from 1963 to 1980. Average verbal scores fell over 50 points and average mathematics scores dropped nearly 40 points; Both the number and proportion of students demonstrating superior achievement on the SATs have also dramatically declined; Average tested achievement of students graduating from college is also lower"(USDE, A Nation at Risk, 1983).

To counteract the risks, the United States Department of Education has made its findings available for public viewing. In the report, Science for All Americans (AAAS, 2007), the meaning of science literacy is defined. The principles of teaching and learning science are outlined and recommendations for science education from Kindergarten through 12th grades are given. Teachers are encouraged to fill in knowledge gaps in their own individual knowledge of science and to pursue professional development. The common body of scientific knowledge that every American should know is emphasized. The vision of a science literate America was given a goal year to concur with its name. The project is called Project 2061, to coincide with the anticipated return of Halley's

Comet (AAAS, 2006). The ACT is an assessment tool that helps determine if the goals of science literacy are in closer view.

Gender and Science Achievement

Historical Perspective

For decades, gender has been considered an influential factor in society. Different cultures used gender to assign wealth, prestige, duties, inheritance and societal rank. Scientific study and debate was something that was left exclusively to the men. Much of this was based on the predetermined role assignment society placed on men and the predetermined role assignment that society also placed on women. The early history of the scientific revolution gave rise to societies of class, profession, religious affiliation and age and the exclusion of women. Modern science brought about the reexamination of whether or not women should study science.

The Royal Society (London), a historically society founded in 1660 under King Charles II, promoted science by studying it in a social environment. Members debated over what was scientific truth by using deductive reasoning. Some of the most famous members of the Royal Society included Robert Hooke, who coined to term "cell" and Robert Boyle, who is known for his gas laws, "Boyle's Law". Membership in such a society was only given to those deemed worthy which excluded women (Lomas, 2002; Purver & Bowen, 1960). The study of natural philosophy was often seen as acceptable study for women because it included the study of virtues and religious sensibility which would be needful knowledge for future women and wives. Although, such academies as "The Female Academy" established in 1662, were established as an alternative, being that women were not permitted membership into the "old boys clubs" , such women ran societies and educational institutions did not receive financial support from patrons as did the men ran societies. This lack of financial support meant that women ran societies and educational institutions did not survive (Magner, 2002). Other societies existed with similar rules on the exclusion and government of women. These included but are not limited to the Royal Academy of Sciences (French) and the French Academy of Sciences. The existing societies often rivaled each other, being that each considered itself as having the answers to science and scientific inquiry (Magner, 2002).

Prior to the 18th century women studied science through private tutors, workshops given at homes or other social gatherings and through the practice of medicine. During the 1830s Mademoiselle de Scudery, Madame des Moulieres and Madame Dacier were denied admittance into the Academy of Science which was largely protested by groups of women. However, by the end of the 18th century women were excluded from even the practice of medicine. Women wrote during this time, volumes of scientific literature that was either published anonymously or under their spouse or another male scientist. Women during this time made known that their exclusion meant the lost of various contributions of half of human kind. In 1911, Marie Curie became the first person to win a second Nobel Prize. This came about one year after she applied to the Academy of Science and was denied membership (Magner, 2002).

Science in the United States during the establishment of the colonies was not looked upon favorably mainly due to religious opposition. In spite of religious opposition, a society modeled after the Royal Society was established in 1683 called the Boston Philosophical Society. The Boston Philosophical Society therefore became the first society devoted to scientific study in the United States. However due to huge disputes involving religion and other matters, it did not survive. The study of science in the United States was largely promoted by the founding fathers Thomas Jefferson and Benjamin Franklin. Franklin established a group called the Junto which philosophically debated natural history and philosophy and later became The American Philosophical Society. The American Philosophical Society is the oldest learned society in the United States and whose early members later became presidents of the United States. These societies and academies, as did its contemporaries, remained independent of governmental influence until World War I. After the war, many of the societies were grouped into councils and institutes. These groups included: the American Council on Education, the National Academy of Sciences, the National Research Council, the American Council of Learned Sciences and the Social Science Research Council. The foundational basis of the National Academy of Sciences is rooted in two societies, the National Institution for the Promotion of Science and the American Society for Geologists and Naturalists. The American Society for Geologists and Naturalists eventually became the American Association for the Advancement of Science, which today is considered the largest organization for the promotion of scientific study and outreach in the world whose members include women and men (AAAS, 2008; Magner, 2002).

Gender Differences

The differences in men and women go far beyond the obvious physiological characteristics (Benbow, Lubinski, Shea, & Eftekhara-Sanjani, 2000). The terms gender difference and sex difference are often used interchangeably but are quite different. Gender differences are differences in men and women due to social, cultural, environmental or other factors than biology. Gender differences are most often associated with the terms masculine and feminine. Sex differences are differences that are 100% biological. Sex differences are more closely associated with male or female as defined by internal and external anatomy and hormone patterns (Bren, 2005). Because gender differences are associated with social, cultural and environmental factors, this makes gender differences easier to control than sex differences. In essence, given the same opportunities outside of physiological and biological constructs, the achievement levels of men and women should not differ.

Math and Science Achievement

Historical Perspective

The value of the math and science relationship has been explored by many scientists and mathematicians for centuries. The Greeks based a lot of their mathematics on inductive reasoning made from scientific observations (Weinkopf, 1995). One of the earliest fields to explore the relationship between mathematics and science was Astronomy. Tycho Brahe, although a famous astronomer and alchemist, is primarily remembered for the accurate mathematical calculations he made that assisted Johannes Kepler with deriving his famous, Three Laws of Planetary Motion. Brahe's data became a standard mathematical tool for the observation of the planets and advanced the field of astronomy.

Because understanding math can improve science achievement, it is important that more aggressive measures are taken to improve the math skills of American students. Improving math education strengthens the economic standing of the United States in the global economy (Geary & Hamson, 2007). In a survey conducted by the American

Council on Education (2006), 70% of Americans believed that math and science skills are important skills for college graduates who want to be competitive in the 21^{st} century. In addition, surveyors found that only 49% felt that math and science was important after graduation (American Council on Education, 2006).

Math, Gender and Science Achievement

According to (Halpern et al., 2007), males have a better working knowledge of math than females. Much of what is known about male and female achievement in math is related to the standardized scores on national standardized achievement tests such as the American College Test and the Scholastic Achievement Test (SAT). Although many standardized tests have been designed to do away with gender bias, recent studies show small differences or no differences at all. While other studies show noticeable differences in the achievement levels of females and males (Neisser et al., 1996). In a study conducted by Yore, Shymansky, Henriques, Chidsey, & Lewis (1987), girls performed better than their male counterparts in science reading. In addition, boys in the same study performed better than girls in hands on science activities.

Males have also been documented as having greater abilities in visual spatial tasks which is sometimes referred to as spatial temporal reasoning (Neisser et al., 1996). Visual spatial tasks are tasks that include but are not limited to being able to see an object within another object or the ability to see and think three dimensionally (Chevrier & Robert, 2003). There are three main categories of visual spatial abilities: spatial perception, mental rotation and spatial visualization. Spatial perception involves the ability to determine the relationship of other objects with one's self as a reference point. Mental rotation is the ability to see objects three dimensionally without regard to how the object is oriented. Spatial visualization includes multi-step manipulation of objects (Linn & Petersen, 1985).

Students who are successful in math have been shown to have the ability to think logically, apply meaning to abstract thoughts, can reason, and can recognize abstract patterns. According to Howard Gardner's Theory of Multiple Intelligence, these abilities are defined as Logical Mathematical Intelligence and Visual Spatial Intelligence. To think logistically is to think scientifically (Gardner, 1983).

Reading Comprehension and Science Achievement

The overall purpose of reading is to comprehend the ideas relayed in written material. Without comprehension of the ideas reading is uneventful, meaningless and without purpose. Proficient readers are able to recognize words rapidly with ease. Readers who have difficulty with recognizing words have difficulty with comprehension. A difficulty in comprehension deters the process of learning. Learning and comprehension are interdependent (Adams, 1990).

Cognitive Development and Learning Theorists

Historically what we know about learning, memory and cognitive development has changed. During the 4^{th} and 5^{th} centuries Greek philosophers taught out of the idea or concept of the Mental Copy Theory. However it was Socrates who first expressed the ideas of basic conditions for learning lie inside the cognition of each individual. Socrates is said to have began many of his lectures posing questions to his students. This was in sharp contrast to the methods of his contemporaries, who were basically the "sage on the stage" for their students. During the 17^{th} and 18^{th} centuries teachers taught out of the Mental Discipline Theories. These theories employed non-experimental psychological methods (R. Hairston, personal communication, September 27, 2004).

The advent of the 20th century marked changes with the introduction of three families of learning theories. The learning theories were based on experimental psychology. These theories included the Behaviorist Stimulus Response Conditioning Theory, Social Learning Theory, and the Cognitive Learning Theory. A Learning Theory is a procedure in which an organism modifies its behavior after trial and error experiences. A Learning Theory therefore comprises a group of constructs, assimilating changes in performances and both the perception and behavior behind how these changes came about (R. Hairston, personal communication, September 26, 2004).

Psychological Constructivism was developed by Jean Piaget. Piaget has been credited to be the leading developer of the Constructivist Learning Theory in a general sense. Much of Piaget's work was centered around cognitive development and memory. Piaget believed that learning takes place when new information does not fit into an individuals' current schema or what one already knows. He further believed that learning takes places in stages. These stages of cognitive development include the Sensorimotor, Preoperational, Concrete Operational, and Formal Operational Thought. The Sensorimotor Stage he believed began at birth and lasted until age 2. During the Sensorimotor Stage the infant learns to utilize his/her senses and motor skills as mental images to construct knowledge. In the Preoperational Stage, which begins around age 2 and lasts to approximately age 6, children learn how to use mental images, numbers and symbols to represent aspects of the world through their own perspective. After the Preoperational Stage children entered what he called the Concrete Operational Stage that is approximately from age 7 to early adolescence. In this stage the child understands and can reason as well as think logically but only on situations that involve the here and now. The last of Piaget's stages is the Formal Operational Thought which begins in adolescence and continues into adulthood. During Formal Operational Thought the adolescent or young adult can think in terms of hypothetical situations, can make speculations and draw conclusions on what may be possible and what may not be possible (Kail & Cavanaugh, 2000).

The impact of what we know about how the brain works and neurological research on education has defined what "best practice" in teaching is. The brain from a neurological standpoint is made of a complex system of nerve cells or neurons. Each neuron has finger-like projections called axons, which carry electrical impulses away from the cell body. Each neuron also has finger-like projections called dendrites that carry electrical impulses to the cell body. Synapses, which are specialized junctions, help nerve cells communicate. Synapses change the electrical impulses transmitted from axons and dendrites into chemical signals that are read by the brain as a particular action.
At birth humans are born with a few synapses. However, as the human develops the human will have trillions of synapses from the learning process. With aging, these synapses deteriorate and a loss of control in neurological function can occur from minimal to severe.

Understanding the impact of neurological research has also altered how teachers teach. The idea that the teacher should be the "sage on stage" does not reflect the current knowledge and constructivist viewpoints. Current knowledge takes the following four assumptions into consideration:

(1) Learning is a result of the learner's interaction with the environment

(2) Learning is a constant change in human performance

(3) Learning is acquired through experience

(4) Learning is a process

In the past centuries, the belief systems were centered around the idea that knowledge and intelligence was "fixed at birth". The educational research contributions of learning theorists such as Lev Vygotsky, Ernst von Glaserfield, John Dewey, Edward Thorndike, B F Skinner, John Watson, Jerome Bruner, David Ausubel, and Howard Gardner helped revolutionize the scientific community on how we see intelligence and how learning takes place.

Lev Vygotsky's and Piaget's views were similar; however, Vygotsky believed that learning precedes development. Piaget believed that development precedes learning. Vygotsky further believed in what he coined as social constructivism. Social constructivism is the belief that individuals construct knowledge from their environment changing the individual as well as the environment. He is most famous for "Zone of Proximal Development".

Ernst von Glaserfield was the founder of radical constructivism. He believed that learning happens internally or within the individual. He further believed that learning does not happen outside the knower and the knower is able to articulate through oral and written communication what he or she has learned.

John Dewey believed that all knowledge is constructed through an individual's social interaction with his community and the world. Moreover, he believed that society is the reference point for making sense of the experience. He was the father of the progressive education movement, pragmatism and instrumentalism. He also started an experimental school based on his beliefs, along with his wife.

Edward Thorndike, B. F. Skinner and John Watson all believed that learners learn from each individual's response to stimulus. This is formerly called operant conditioning. Operant conditioning is learned from the result of various trial and errors (response to certain stimulus or consequences). Furthermore, they believed that the learner must be active and not passive and that instruction must be given in small steps with feedback at each step in the process.

Jerome Bruner believed that education, especially, science should help the development of problem solving through discovery learning. Discovery learning is also called inquiry-based learning. Bruner thought that active learning is the basis for true understanding. He believed in building on prior knowledge. He is most famous for his work with the National Science Foundation in curriculum development.

David Ausubel was an educational psychologist famous for his studies on the human brain. He studied the difference between meaningful learning and rote learning. Meaningful learning is when the individual can relate new knowledge with prior knowledge or what he or she already knows. Ausubel believed that rote learning did not require any effort to relate prior knowledge with events, objects or concepts.

Howard Gardner was a Harvard professor who first designed his theory of multiple intelligence in 1983. Since then, the theory has expanded from 7 intelligences to 8. Prior to Gardner, many people believed that intelligence could be solely based on traditional IQ testing that included only linguistic skills and logistical and mathematical skills. However, Dr. Gardner revealed that intelligence can reside within 8 separate individual categories: They are: (1) Linguistic, (2) Logical and Mathematical, (3) Interpersonal, (4) Intrapersonal, (5) Music, (6) Bodily Kinesthetic, (7) Spatial, and (8) Naturalistic.

The American College Test takes into consideration that students who take the exam understands the following: the basics of word mechanics and punctuation, can read and write, can comprehend what they have read, are able to express themselves in writing, have a functional level of logistical and mathematic skills and can think and reason scientifically. These are all skills that the learner should have acquired prior to entrance into college (Barrons Regents, 2008).

Mathematics achievement is based on the principal that a student has a working knowledge of numbers, logic and the ability to think critically. Science reasoning builds on the idea that a student can think and reason scientifically by employing the basic science process skills as outlined in the Biological Sciences Curriculum Study: Observing, Communicating, Classifying, Measuring Metrically, Inferring, and Predicting (Hairston, 2004; Rezba et al., 2003). This study examined the scores students earned on the ACT and their achievement measured by the final grades earned in a Physical Science class.

Reading Comprehension and the Constructivist Learning Theory

Reading comprehension is also related to the prior knowledge of the individual. Prior knowledge is simply how much an individual already knows. The role of prior knowledge has been studied by many learning theorists. Jean Piaget (1950) pioneered the Constructivist Learning Theory, which suggests that individuals learn by constructing new knowledge with existing knowledge. The two main processes of knowledge acquisition in the Constructivist Learning Theory are accommodation and assimilation. Accommodation and Assimilation are both internal processes. Accommodation is the process of learning through trial and error. After trying a task over and over again an individual makes adjustments or accommodations based on the outcomes of the task. This new knowledge construction is incorporated or assimilated into what the individual already knows. Therefore, assimilation is taking the new knowledge and incorporating the new knowledge into what one already knows (Kim, 2005; Piaget, 1950).

Foundational Studies in Reading Comprehension and Relevant Theories

The study of reading has led to research on the cognitive process involved in reading comprehension. During the 20th century, many researchers conducted experimental analyses of reading comprehension. One of the earliest was W.S. Gray in 1919 with his Eighteenth Yearbook of the National Society for the Study of Education (Gray, 1919). He made the following conclusions from experimental analyses in which he named eight skills of reading comprehension:

(1) To read for the purpose of giving a coherent reproduction

(2) To determine the central thought or the most important idea of a selection

(3) To select a series of closely related points and their supporting details

(4) To secure information which will aid in the solution of a problem

(5) To gain clear comprehension of the essential conditions of a problem

(6) To discover new problems in regard to a topic

(7) To determine the lines of argument which support the point of view of the author

(8) To determine the validity of statements. (Davis, 1972)

Although Gray was one of the earliest contributors to the understanding of the processes involved with reading, other researchers have made major impacts into our current understanding of reading comprehension. One of these researchers whose studies have influenced our current understandings was Benjamin Bloom. Bloom developed a taxonomy of educational goals. He was the first to discover that there are different types of learning. He developed the idea of three categories in which learning takes place. He called these categories domains. These domains Bloom identified were the: Cognitive Domain, Affective Domain and Psychomotor Domain. For the purpose of this paper, only the Cognitive Domain will be discussed in detail.

The Cognitive Domain involves the development of mental skills. In the Cognitive Domain there are six categories. These categories include: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation. The Knowledge category involves recollection of specific facts and procedures. An example in this category would be to recite the Preamble to the United States Constitution or to know lab safety rules. Questions or actions would involve terms like define, identify, recall and list to name a few.

The next category under the Cognitive Domain is Comprehension. The Comprehension category involves interpretation of facts and understanding of meaning. An example in this category is to put the Preamble of the Constitution in your own words or to interpret the instructions on a document. Questions or actions would involve terms like summarize, infer, explain and distinguish. Another category under the Cognitive Domain is Application. The Application category involves putting into practice what has been learned. Here knowledge learned is applied. An example in this category would be to use a given formula(s) to solve a mathematical equation or to demonstrate ability on a laboratory exercise to test the proficiency of an analyst. Questions or actions would include discover, relate, demonstrate and compute.

The Analysis category of the Cognitive Domain involves separation of fact from inference. Analysis examples would include troubleshooting a problem with an automobile or being able to gather information from restaurant reports to determine how to improve the overall quality of the restaurant. Questions or actions might include compare, contrast, differentiate and outline.

The Synthesis category of the Cognitive Domain involves putting parts together to form a different meaning or new structure. Synthesis examples would include writing a training manual or devising a plan of escape in case a burglar invades the home. Questions or actions might include combine, devise, compose and write.

The Evaluation category of the Cognitive Domain involves assessing the value of materials or ideas. Evaluation examples would include defending a presidential candidate or selecting the most energy efficient automobile. Questions or actions might include critique, justify, explain, and defend. Being that the Cognitive Domain of Blooms' research included the category Comprehension, researchers have used this taxonomy to develop models, teaching aids and evaluation tools to further understand how to improve reading comprehension skills of individuals (Clark et al., 1984).

Reading research has shown that comprehension is not a passive process but one in which the reader is actively involved. Recent studies have also shown that the direction of learning through comprehension is not simple. According to Kitaeo 1990, meaning does not come from additive processes as once proposed. Earlier theories such as that of

LaBerge and Samuels (1974) proposed that readers form meaning from symbols and then put symbols into morphological clusters and from morphological clusters words are formed. After the words are formed the learner is able to form phrases and from phrases sentences. The theory of Schemathelogy is the theory that explains how a reader arrives at comprehension. It incorporates prior knowledge coupled with the active engagement and the rhetorical knowledge of the reader. Knowledge of rhetorical patterns such as cohesive ties aid in comprehension. An example of cohesive ties would be transitional terms. Transitional terms signal patterns of change in the text that a skilled reader recognizes and therefore comprehends. Without the knowledge of textual schemes an unskilled reader misinterprets the implied meaning (Kitaeo, 1990).

The research studies of Gray, Bloom and Kitaeo all focused on the reading practices that lead to our current understanding of how we view comprehension today. The cognitive functions and abilities employed in comprehension are relative to the cognitive process skills also required for success in science courses.

Science Reasoning and Science Achievement

Our understanding of science reasoning has evolved over time. Preliterate man based all of his reasoning on religious or spiritual beliefs to explain the phenomena of his world. Some of these belief systems included animism, shamanism and totemism. Animism is defined as the belief that inanimate objects or creatures have human characteristics. An example of animism would be, the sun and the moon worshiped as gods. Shamanism is the belief that a priest, called a shaman, has a direct communication with the spirit world through rituals in which sometimes he is rendered unconscious. People who practice shamanism trust the shaman, which means “one who knows”, with making decisions for their lives. The shaman is also believed to have the ability to cure the sick and raise the dead. Totemism is the belief that a figure or animal watches over a group of people. Totemism was very prevalent in the 19^{th} and 20^{th} centuries in the religious belief systems. Totemism is an effort to explain the world by using physical analogies. Claude Levi-Strauss, a social anthropologist who studied early belief systems, argued that because primitive people used physical analogies to explain or reason their world, did not indicate a primitive mental capacity. Levi-Strauss also added that human cognitive processes are independent of social context. Therefore, logic and reasoning can be learned, adapted or modified (Lane, 1968).

The ability to reason logically is very important to achievement in science courses. Scientific reasoning is based theoretically on the research of Piaget (Piaget & Inhelder, 1958), being that the ability to reason scientifically employs the use of cognitive skills. Recent studies conducted at an institution of higher learning have shown that the science curriculum, increased science courses, undergraduate psychology courses, courses in humanities and calculus based physics can positively influence the scientific reasoning ability of college level students (Rifkin & Georgakakos, 1996).

Scientific reasoning involves the principles that are pertinent to the task at hand. These principles include the design of the experiment, testing the hypothesis and analyzing of data. Good scientific reasoning involves being able to understand the purpose behind what's being done, formulating hypothesis, making predictions, testing predictions, analyzing and interpreting data, and communicating effectively what is and what is not (Lau & Chan, 2008). Scientifically reasoning what is and what is not is the focus of inductive and deductive reasoning.

Inductive reasoning is logic derived from observing a pattern or experiential data that the outcome is repeated over and over again. Inductive reasoning starts from specific and widens to a broad concept. An example of inductive reasoning is; all ducks I've seen have had feathers therefore, all ducks must have feathers. Deductive reasoning is logic that is derived from known truths. Deductive reasoning starts from the broad and narrows to a specific concept. An example of deductive reasoning would be: All ducks have feathers. Howard is a duck. Howard must have feathers. Although deductive reasoning and inductive reasoning are useful, induction is used more in scientific reasoning because it is based on generalizations.

According to State Council of Higher Education for Virginia (2006), individuals who are competent in scientific reasoning should be able to: determine the relationship between physical quantities, develop experiments to test predictions concerning the relationship between physical quantities, determine possible outcomes of experiments and explain why certain outcomes occurred, and validate the results based on previous investigations.

Science educators practice inquiry based learning techniques to facilitate the process of learning in science courses. Inquiry based learning is learning in which the student through activities or guided practice is given the opportunity to explore the relationship between concepts and formulate his or her own conclusions by reasoning scientifically. The Basic Science Process Skills (BSPS) is an instructional tool used to help students actively engage in science activities. Utilizing the BSPS, students make predictions, make inferences, classify similarities and differences, quantify by using measurement, make observations, communicate orally and in writing from which students reason scientifically and form conclusions based on what they already know, what they observe and what they can scientifically reason (Rezba et al., 2003).

According to the Attribution Theory, a students' scientific reasoning can be improved by using a teaching activity that focuses attention on the causal explanatory nature of psychological theories. The activity that is used is called the inference to the best explanation or IBT. Students during IBT can learn to reason scientifically by making logical deductions based on what the cause and effect relationship is in the phenomena they are observing (Eflin & Kite, 1996). One scientist can not claim to know everything because knowledge is never absolute. This is primarily due to the tentative nature of science and the fact that paradigms shift. Shifts in paradigms mean that scientific reasoning can change over time.

CHAPTER III

RESEARCH METHODOLOGY

The purpose of this research was to collect quantitative data that could help identify some of the factors that influence African-American achievement in science. This chapter describes the setting, participants, research design, instrument and method of analysis. The research conducted in this paper addressed the following hypotheses:

1. There would be a significant difference in the raw scores of African-American females in comparison to African-American males on the American College Test subtests.
2. There would be a significant difference in the final grades of African-American females in comparison to African-American males earned in Physical Science courses.
3. The subscores of African-American students on the reading comprehension, mathematical skills and science reasoning portions of the American College Test would positively correlate with each student's individual Physical Science final grade.

Setting

Prior to beginning this study a research proposal was submitted for approval to the Institutional Review Board at both the research HBCU and The University of Southern Mississippi. After the proposals were reviewed approval letters were sent to the address listed on the research proposal. Upon receipt of approval letters from the research HBCU(Appendix A) as well as The University of Southern Mississippi (Appendix B) during the Fall of 2008, the study was initiated.

The study was conducted at a historical black college or university in the southeastern portion of the United States. The research population was African-American students enrolled in Physical Science.

Physical Science is a science option for students who are not majoring in science or a science-related discipline. Occasionally other science options such as Astronomy and General Science are offered. The other science options are offered based on student interest and faculty availability. According to the Institutions of Higher Learning, all students must have a science course in order to receive a college degree. This assures that all college students have some level of science literacy upon graduating from an accredited university. Students taking Physical Science were required to purchase the same Physical Science textbook. A standardized syllabus (Appendix C) was given to each student taking Physical Science that outlines the course requirements. A department designated officer, deemed the Coordinator of the Physical Science Classes, determined the content of what was taught in Physical Science Classes at the research HBCU. The Physical Science class taught was not based solely in Chemistry. However, the course covered certain principles used in Chemistry such as the study of physical and chemical changes, the states of matter and the study of elements. The course also incorporated the basic principles of Meteorology, Geology, Astronomy and Physics. There were nine sections of Physical Science during the semester in which the research was conducted. However if a greater need develops due to increased enrollment, other sections generally are added to fill the need. Seven of the nine sections participated in the study. Classes met once a week for a two hour lecture and one hour a week for laboratory activities. Evening classes met once a week for four hours, which included laboratory activities.

Participants

The participants in this study were students enrolled in Physical Science classes at the same university. The participants in this study were all African-American. Both genders participated in the study. The classroom size ranged between 15-35 students per class. The number included in the study was 120 from different course sections of Physical Science. Each student that participated in the study was asked to take a survey.

Research Design

The ACT was developed in 1959 as an alternate standardized college admissions test. Prior to its development, the SAT was the only accepted test for admissions to universities and colleges. Although both the SAT and ACT have undergone several revisions, each remains a very important means of assessing the academic achievement levels of students prior to college. The ACT originally consisted of four subtests until 2005, in which a writing component was added to the English, Mathematics, Reading Comprehension, and Science Reasoning subtests. In this study the English and Writing portions were not investigated because the reviewed literature showed more of a positive correlation to the chosen predictors involved in this study.

The results of the American College Test were used to measure the student's academic performance from three of the five subtests included in the ACT.
The subtests included were Reading Comprehension, Mathematics and Science Reasoning. ACT scores were submitted as part of the application process for prospective undergraduates at the research HBCU. In order to gain admission to the research HBCU under regular admissions, students are granted four options. The first option is to complete a college preparatory curriculum with a minimum 3.2 grade point average

(GPA) on a 4.0 scale. The second option granted is to complete the college preparatory curriculum with a minimum 2.5GPA or in the 50th percentile in class rank with a minimum ACT score of 16 or SAT equivalent. The third option granted to students is to complete the college preparatory curriculum with a minimum 2.0GPA and an 18 on the ACT or SAT equivalent. The fourth option under regular admissions granted is to satisfy the National College Athletic Association Requirements. Students under this option are considered as "full qualifiers" under the Division I Guidelines. These guidelines require that students must have a 2.5GPA on the college preparatory curriculum and have a minimum ACT score of 17 or SAT equivalent. Students who do not meet the regular admissions requirements must participate in a screening test called the "Accuplacer Test". If students pass this test, regular admission is granted. If students do not pass the Accuplacer test, a summer remediation program is required to obtain admission. The summer remediation program is a nine week program from June through August. In addition, students must actively participate in a year long support program. If students do not pass the summer remediation program, they are advised to pursue other educational options.

Students were asked for permission to obtain the ACT scores submitted to the admissions office as part of the undergraduate application process at the research HBCU. Students were informed that the scores would be used only for the purpose of this study and that information would remain confidential. In addition, students were made aware that participation was on a voluntary basis and would not affect the class grade. The researcher obtained written consent, presented the purpose of the study orally and answered any questions directed from the students. Also, students were asked to complete a personal data survey sheet (Appendix D) and informed that there were not any right or wrong answers. Physical Science teachers were asked to submit midterm and final grades at the end of the study. Three Physical Science instructors participated in the study, with students from seven different sections. Two instructors that participated in the study taught two sections of Physical Science and the third instructor taught three sections.

Method of Analysis

The statistical program that was used to analyze the data was the SPSS. The SPSS data analysis included t-tests and chi squares set at the .05 significance level. The research conducted in this paper addressed the following hypotheses:

1. There would be a significant difference in the raw scores of African-American females in comparison to African-American males on the American College Test subtests.
2. There would be a significant difference in the final grades of African-American females in comparison to African-American males earned in Physical Science courses.
3. The subscores of African-American students on the reading comprehension, mathematical skills and science reasoning portions of the American College Test would positively correlate with each student's individual Physical Science final grade.

CHAPTER IV

RESULTS OF DATA ANALYSIS

Introduction

The purpose of this research was to provide data that could help identify some of the factors that influence African-American achievement in science. The research population included students who were not science majors enrolled in a Physical Science course at a historical black college or university. The results in this research would enable science educators and researchers to design programs that would build the reading comprehension, science reasoning and mathematic skills of college level students. This research also explored the role of gender and science achievement. The improvement of these skills would help students succeed in science as well as graduate school programs.

Students were asked to complete the personal data information sheet that asked students to select from choices provided their individual: gender, race, current age group, major, state of high school attended, whether their high school was public or private, if the high school was religious based or not, high school setting, high school size, number of science classes taken in high school, grade expected in the college level Physical Science course, if specified math courses were taken, if specified language arts courses were taken and how many parts, if specified science courses were taken, whether or not they had children, worked while taking the college level Physical Science course and how many hours studied per week in preparation for the Physical Science course. The format for the personal data information sheet is included in Appendix D.

The total number of students taking Physical Science during the Fall of 2008 was 225. Because the research conducted in this study was based on research of African Americans, 12 students of the 225 were eliminated because they identified themselves as a race other than African American on the personal data information sheet. Ninety-three students chose not to participate in the study. Therefore, a total one hundred twenty (N=120) students volunteered to participate in this study. Therefore a total of 120 personal data information sheets were administered in various sections of Physical Science classes at the research HBCU. In addition, students gave written consent to utilize their ACT scores as part of the analysis.

Descriptive Data

Background information of students that participated in the study is listed in the following labeled, Table 1 and Figure 1. Table 1 includes the gender and age. Figure 1 includes the major of the participants. All students participating in the study were African American non-science majors taking Physical Science and attending the same historically black college or university in the Fall of 2008. The total number of students who participated in the study was 120, consisting of both genders from various majors and age groups. The majority of students were females, elementary education majors and between the ages of 18-19.

Table 1

Background Information (Gender and Age)

	Count	Percent
Gender		
Male	49	40.8
Female	71	59.2
Age		
18 – 19	40	33.3
20 – 21	39	32.5
22 – 23	19	15.8
24 – 25	7	5.8
Other	14	11.7
Information not provided	1	.8

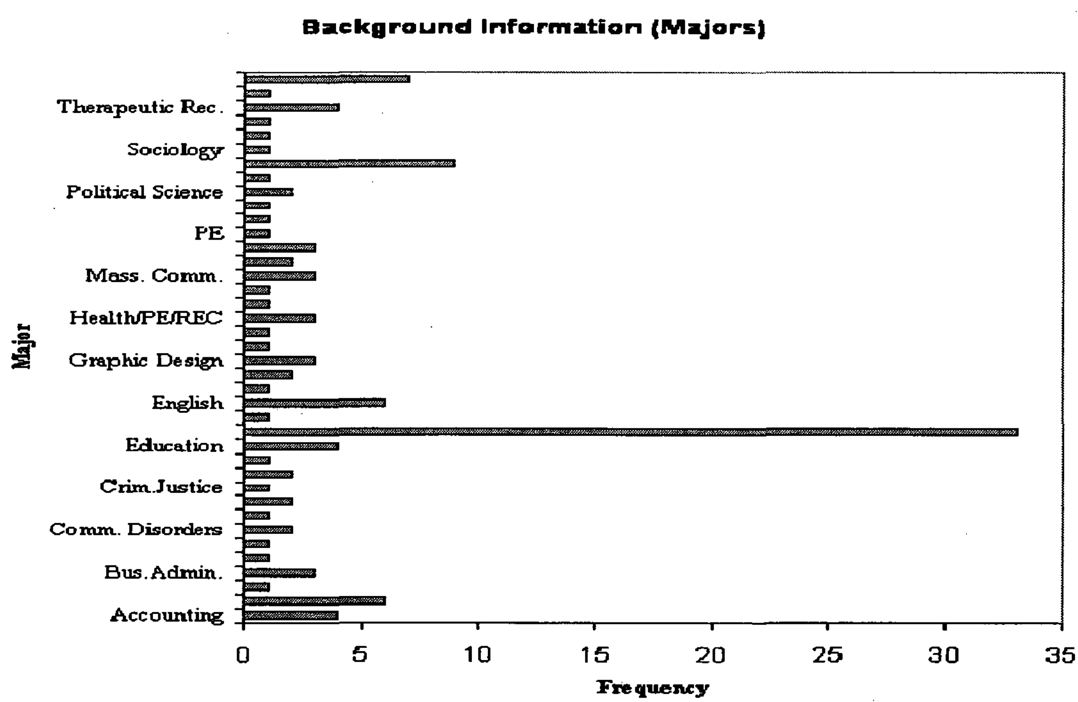

Figure 1. Majors of participants

The information listed in Table 2, "High School Characteristics", lists the type, location and size of the high school students attended based on a range. Table 2 also includes whether the high school public or private or religious or not. In addition, Table 2 tells whether the schools attended where in a rural, suburban or urban location and the size of the school. Figure 2 labeled, "Participants by Home State", includes the state in which students attended high school. Of 120 students, the majority attended urban public high schools. Most students attended schools with student populations over 1000. The majority of students resided within the state of Mississippi during their high school years.

Table 2

High School Characteristics

	Count	Percent
Type		
Private	5	4.2
Public	115	95.8
Religious		
No	115	95.8
Yes	5	4.2
Location		
Rural	23	19.2
Suburban	26	21.7
Urban	67	55.8
Size		
Under 100	2	1.7
101-500	34	28.3
501-1000	38	31.7
Over 1000	46	38.3

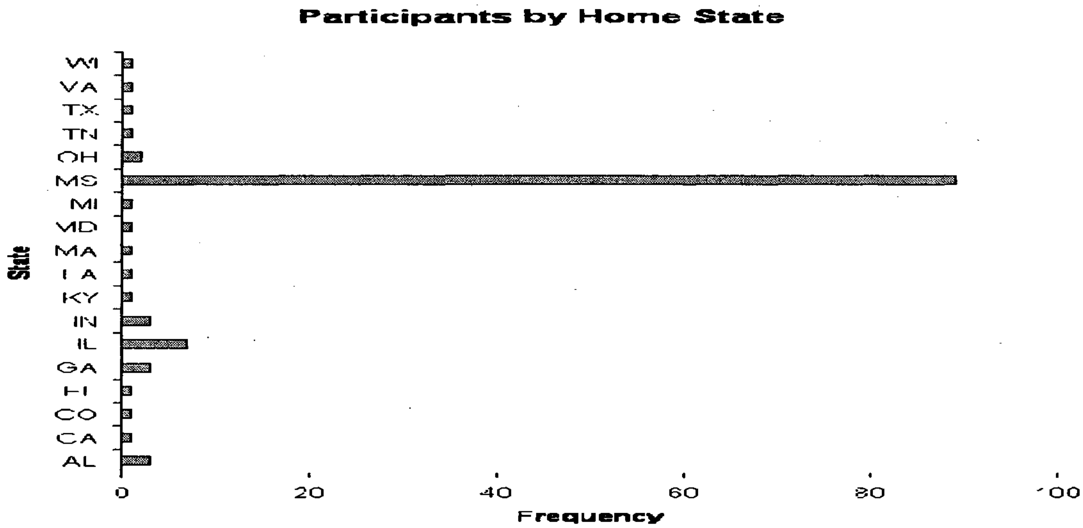

Figure 2. Home states of the participants

The information listed in Table 3 labeled, "Science Classes Taken in High School", includes the number of science classes taken by students participating in the study. Table 3 also includes student responses on whether students took the following courses in high school: Biology, Chemistry, Physics, Physical Science or any other science courses. Of 120 students, the majority took Biology, Chemistry and Physical Science. However, the majority of students indicated that they did not take Physics in high school. In addition, most students indicated taking at least 3 science courses. The majority of students also indicated not taking any other science classes other than those listed on the personal data information sheet.

Table 3

Science Classes Taken in High School

	Count	Percent
Biology		
No	5	4.2
Yes	115	95.8
Chemistry		
No	34	28.3
Yes	86	71.7
Physics		
No	101	84.2
Yes	19	15.8
Physical Science		
No	51	42.5
Yes	69	57.5
Took Other Science Courses		
No	93	77.5
Yes	27	22.5
Number of Science Courses Taken		
1	6	5
2	8	6.7
3	55	45.8
4	51	42.5

The information listed in Table 4 labeled, "Math Classes Taken in High School", includes the number of math classes taken by students participating in the study. Students were asked if the following math courses were taken in high school: Algebra 1, Algebra 2, Geometry, Trigonometry and Calculus. Students were also asked if additional math courses were taken. Of 120 students, most students indicated that they took Algebra 1, Algebra 2 and Geometry. Most students indicated they did not take Geometry or Calculus. Also students indicated not taking any other math classes other than those listed on the personal data information sheet.

Table 4

Math Classes Taken In High School

	Count	Percent
Algebra 1		
No	12	10
Yes	108	90
Algebra 2		
No	26	21.7
Yes	94	78.3
Geometry		
No	12	10
Yes	108	90
Trigonometry		
No	81	67.5
Yes	18	15

Table 4 (Continued)

	Count	Percent
Calculus		
No	102	85
Yes	18	15
Took Other Math Classes		
No	102	85
Yes	18	15

The information listed in Table 5 labeled, "Language Arts Classes Taken in High School", includes the number of language arts classes taken by students participating in the study. Students indicated in Table 5 whether the following classes were taken in high school: Literature, Journalism, Learning Strategies and English. Students also indicated if numerous parts of English and if any other language arts classes were taken. Of 120 students, most students did not take Learning Strategies or Journalism in high school. However, the majority of students did indicate that they took Literature, English and several parts of English. In addition, most students indicated that they did not take any other Language Arts classes other than those listed on the personal data information sheet.

Table 5

Language Arts Classes Taken in High School

	Count	Percent
Literature		
No	44	36.7
Yes	76	63.3
Journalism		
No	107	89.2
Yes	13	10.8
Learning Strategies		
No	120	87.5
Yes	15	12.5
English		
No	9	7.5
Yes	111	92.5
Other Language Arts Courses		
No	113	94.2
Yes	7	5.8
Total Number of English Courses		
0	20	16.7
1	1	.8
2	11	9.2
3	6	5
4	77	64.2
7	2	1.7

The information listed in Table 6 labeled, "Time Spent Outside of School", includes the activities that may impact student performance. Activities listed were: employment, children and number of hours the student studies for the college level

Physical Science course. Of 120 students, most students indicated that they were unemployed, the majority of students also indicated that they did not have children. In addition, the majority of students indicated that they studied less than 1 hour per week for the college level Physical Science course.

Table 6

Time Spent Outside of School

	Count	Percent
Total Students	120	
Employment		
Full-time	27	22.5
Part-time	37	30.8
Student worker	14	11.7
Unemployed	42	35
Student has children		
No	93	77.5
Table 6 Continued		
Yes	27	22.5
Number of Study Hours per Week		
Less than 1	82	68.3
1-2	20	16.7
3 or more	18	15

The information listed in Figure 3 labeled, "Grade Expectations and Midterm and Final Grades", includes the grades that students expected to make in the college level

Physical Science course. Table 8 also includes the actual midterm and final grades students earned in the Physical Science course. Of 120 students, the majority of students expected to earn a grade of B. However the majority of students actually earned a midterm grade of F. The final grades revealed the majority earned a grade of C in the college level Physical Science course.

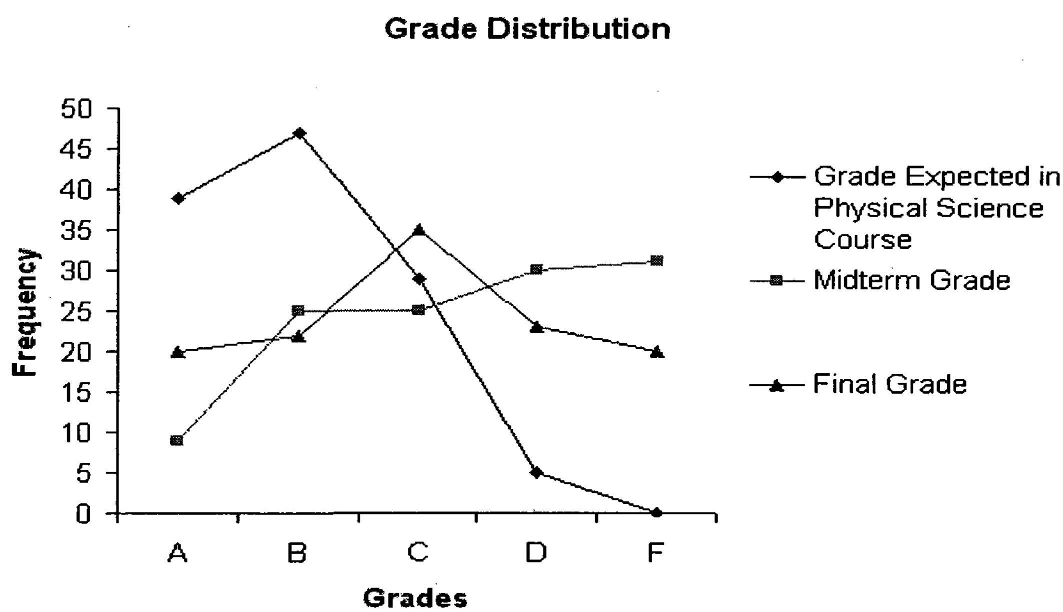

Figure 3. Distribution of expected grades, midterm grades and final grades

The information listed in Figure 4 labeled, "ACT Subscores" includes the math, reading comprehension, and science reasoning scores students earned on the ACT. Of 120 students, the majority scored between 16-19 on the math portion of the ACT. The majority of students on the reading comprehension portion of the ACT scored between 16-19. Student majority also scored between 16-19 on the science reasoning portion of the ACT. The national average for the ACT subtests including math, reading comprehension and science reasoning for the years 2002-2006 was 21 (ACT

Incorporated, 2007). Therefore, the majority of students scored below the national average.

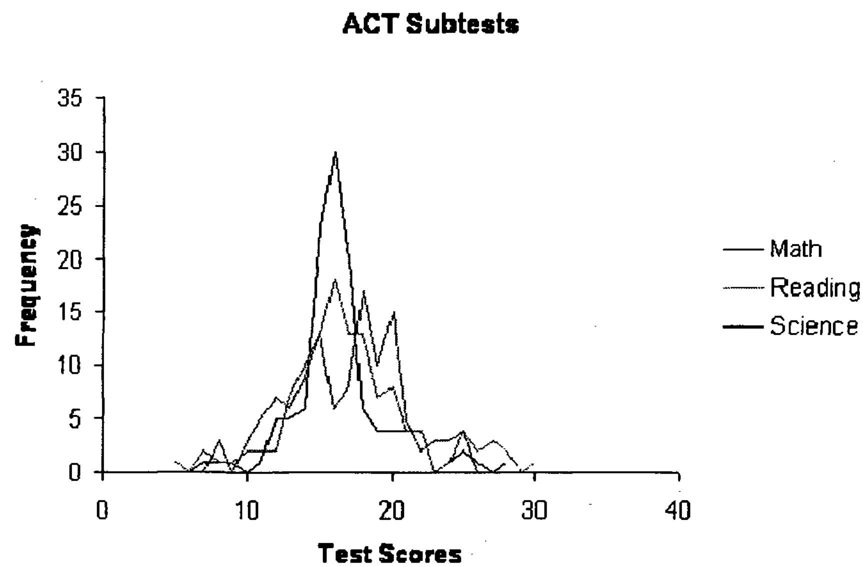

Figure 4. Distribution of ACT subtests scores of participants

The research investigated other factors that may affect student achievement based on the information retrieved from the personal data information sheet. This information is listed in Table 7. These factors included the age of the student, the number of hours the student studies per week for the college level Physical Science course, if the student had children, if the student was employed and grade expected in the college level Physical Science course. Other factors investigated were midterm and final grades. A Pearson correlation was conducted to analyze this data. The results did not reveal any significant correlations.

Table 7

Other Factors Affecting Performance

	Final Grade
Number of Study Hours per Week	
Pearson Correlation	.056
Sig. (2-tailed)	.546
Student Has Children	
Pearson Correlation	.049
Sig. (2-tailed)	.593
Employment	
Pearson Correlation	-.072
Sig. (2-tailed)	.432
Number of Science Classes	
Pearson Correlation	.099
Sig. (2-tailed)	.283
Age	
Pearson Correlation	.088
Sig. (2-tailed)	.343

The research conducted in this paper addressed the following hypotheses:

Hypothesis 1: There would be a significant difference in the raw scores of African-American females in comparison to African-American males on the American College Test subtests.

A t-Test was conducted and revealed that there is no significant difference in the raw scores of African-American females when compared to African-American males. The following data was retrieved from the t-Test ran between both groups, male and female for the three subtests areas of the ACT: Math, Reading Comprehension and Science Reasoning. The means for both males and females are found in Table 8. The female mean score for the math ACT subtest was higher than males. The mean score for the reading comprehension ACT subtest was also higher than males. In addition, the science reasoning ACT scores was also higher among females when compared to males. A significant difference was not observed between the females and males on the ACT math subtest, $t(118) = -.788$, $p=.43$; reading comprehension subtest, $t(118) = -1.443$, $p= .15$ or on the science reasoning subtest, $t(118) = -1.465$, $p=.15$.

Table 8

ACT Descriptive Statistics

	N	Mean	SD
Math ACT			
Male	49	16.16	3.68
Female	71	16.63	2.88
Reading Comprehension ACT			
Male	49	16.59	3.98
Female	71	17.76	4.59
Science Reasoning ACT			
Male	49	16.14	4.12
Female	71	17.23	3.96

Hypothesis 2: There would be a significant difference in the final grades of African-American females in comparison to African-American males earned in Physical Science courses.

A cross-tabulation of the final grades of male and female students was conducted, N=120, 49 males and 71 females. The results revealed the majority of students that earned an A and a B in as final grades were female. In addition, more males earned a C as a final grade. More females earned a D. However, more males earned an F as a final grade in the Physical Science course. These results are listed in Table 9. Pearsonian chi-square tests were conducted to determine goodness of fit, X^2=6.11, *df* = 1, p= .191. Although the grades of females were higher than males, there was not a significant difference between the final grades of African American females and African American males observed.

Table 9

Final Grade – Gender Cross-Tabulation

	Count	Percent
Final Grade		
A		
Male	6	12.2
Female	14	19.7
B		
Male	6	12.2
Female	16	22.5

Table 9 (Continued)

	Count	Percent
C		
Male	16	32.7
Female	19	26.8
D		
Male	9	18.4
Female	14	19.7
F		
Male	12	24.5
Female	8	11.3

Hypothesis 3: The subscores of African-American students on the reading comprehension, mathematical skills and science reasoning portions of the American College Test would positively correlate with each student's individual Physical Science final grade.

A Pearson correlation was conducted and positive correlations were observed. Although positive correlations were observed between math ACT and final grades, results were not significant, $r = .131$, $N=120$, $p = .155$. There was also a positive correlation between reading comprehension and final grades, but results were not significant, $r = .072$, $N=120$, $p = .434$. In addition, a positive correlation was observed between science reasoning ACT and final grades. These results were also not significant, $r = .109$, $N = 120$, $p = .237$.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Introduction

The idea behind this research was to find a means of improving the achievement level of African American non-science majors enrolled in college level Physical Science courses at the research university, an HBCU. The purpose of this research was to collect data that could help identify some of the factors that influence African-American achievement in science. The results of this research would enable science educators and researchers to design programs that could build the reading comprehension, science reasoning and mathematic skills of college level students. The improvement of these skills could help students succeed in science as well as graduate school programs.

The findings of this research could also help diminish gender bias in science, increase the presence of African Americans in science careers and emphasize the importance of steadfast mentoring, tutoring and educating of African Americans regarding possible career choices in science and science-related disciplines. This paper focused on the assumption that a lack of success in science had strong economic and societal consequences (Alliance for Excellent Education, 2006; Geary & Hamson, 2007).

Lack of achievement in science and math impacts the future of African Americans. As the population of the United States increases, the graduation rates of minorities steadily decline (Alliance for Excellent Education, 2006). The ability to understand and improve science achievement would therefore increase the presence of African Americans in the fields of science and technology (Williams, 2008).

The promotion of global competitiveness through science literacy depends on identifying those factors that could positively affect science achievement in Physical Science courses at historically black universities or colleges. Therefore the results of this research could provide information that would enhance scientific knowledge and improve both science literacy and science achievement.

Previous studies have focused on the science achievement levels of students (Beaton et al., 1996; Harding & Parker, 1995; Mullis et al., 1998; Von Secker & Lissitz, 1999). These studies have found a correlation between achievement and success in life. It has also been well documented the struggles African Americans have due to an insufficient knowledge of science and math (Darling-Hammond, 1998; Ikpa, 2003; Johnson & Kritsonis, 2006).

Summary and Discussion of Findings

The participants in this study were African American college level students attending the same HBCU. The study included both male and female students. Participants were all non-science majors taking the Physical Science course as an option to fill the science requirement for their individual programs of study and to fulfill university graduation requirements. Occasionally some science majors choose to take the Physical Science course as an elective. However the course is primarily designed for non-science majors.

The research conducted in this paper was based on three hypotheses. The first hypothesis stated that there would be a significant difference in the raw scores of African-American females in comparison to African-American males on the American College Test subtests. The results based on my research did not support this hypothesis. Although results found indicated a difference among male and female groups, differences found were not significant based on the data collected. The literature itself indicated that females outperformed males from grade school to college and that this had been a trend since 1996 (Mead, 2006). Other literature found that females have higher grades compared to those of males of the same age with similar abilities (Chicago News Office, 2006). Also based on the literature, females outperformed males in science reading which would also account for better scores in science related courses (Halpern et al., 2007). Halpern et al. (2007) also stated that many standardized tests have done away with gender bias making the ACT, being a standardized test for college entrance, a good tool for assessment.

The second hypothesis stated that there would be a significant difference in the final grades of African-American females in comparison to African-American males earned in Physical Science courses. This hypothesis was also not supported based on the data collected in this research. The results did not indicate a significant difference between male and female final grades. According to Halpern et al. (2007), males had a better working knowledge of math than females. Some studies show noticeable differences in the achievement levels of females and males (Neisser et al., 1996). In a study conducted by Yore, Shymansky, Henriques, Chidsey, & Lewis (1987), girls performed better than their male counterparts in science reading. In addition, boys in the same study performed better than girls in hands on science activities. Males have also been documented as having greater abilities in visual spatial tasks which is sometimes referred to as spatial temporal reasoning (Neisser et al., 1996). Much of the literature

The third hypothesis indicated that the subscores of African-American students on the reading comprehension, mathematical skills and science reasoning portions of the American College Test would positively correlate with each student's individual Physical Science final grade. Although the results indicated a positive correlation between the math ACT, reading comprehension ACT, science reasoning ACT and the final grades in the college level Physical Science course; results were not significant. The results were not supported by the literature reviewed for this research. These math ACT results do not agree with the findings of Howard Gardner (1983) based on his Theory of Multiple Intelligences. Students who were successful in math have been shown to have the ability to think logically, apply meaning to abstract thoughts, can reason, and can recognize abstract patterns. To think logistically is to think scientifically (Gardner, 1983). Therefore students who did well in math would tend to do well in science.

Readers who had difficulty with recognizing words had difficulty with comprehension, according to the literature. A difficulty in comprehension deters the process of learning. Learning and comprehension were considered interdependent (Adams, 1990). Therefore, comprehension in science or any subject area was dependent on the individual's ability to read. The results also supported the previous findings which suggested that individuals learn by constructing new knowledge with existing knowledge. The two main processes of knowledge acquisition found in The Constructivist Learning Theory, accommodation and assimilation. Accommodation is the process of learning through trial and error. After trying a task over and over again an individual makes adjustments or accommodations based on the outcomes of the task. This new knowledge construction is incorporated into what the individual already knows, or has already comprehended (Kim, 2005; Piaget, 1950). The findings agree with previous research concerning reading comprehension.

The ability to reason logically is very important to achievement in science courses. Scientific reasoning is based theoretically on the research of Piaget and Inhelder (1969), being that the ability to reason scientifically employs the use of cognitive skills. Recent studies conducted at an institution of higher learning have shown that the science curriculum, increased science courses, undergraduate psychology courses, courses in humanities and calculus based physics can positively influence the scientific reasoning ability of college level students (Rifkin & Georgakakos, 1996). The findings in this research concur with the findings of previous studies regarding science reasoning by Piaget and Inhelder (1969) and Rifkin and Georgakakos (1996).

Limitations

1. This study was limited to the 7 sections of non-science majors in classes at the research HBCU.
2. This study was limited to students who agreed to volunteer to participate in the study and therefore missing other pertinent data that could have been gained from those who did not agree to participate in the study.
3. This study was limited to the honesty and discretion of the student participating in the study. Some students could have answered questions in haste or limited responses to correspond with a preconceived preferred opinion.
4. ACT subtest scores retrieved from the admissions office may not have been accurate.

Reflections and Recommendations

Researchers who are interested in investigating the science achievement levels of African-American non-science majors should make the following considerations prior to conducting research in this area:

1. This study did not take into consideration the differences in the instructional methods of the various instructors involved in the study. The delivery and teaching style of each instructor differs even with uniform lessons and assignments being given.
2. This study can be expanded to include other minorities or ethnic groups.
3. This study did not consider the various learning styles of students, the role of inquiry based learning or computer technology. The impact of learning styles alone is worthy of further research.
4. This study could be expanded based solely on demographics or regional studies.
5. This study could also be expanded to explore how other factors influence achievement in the college level Physical Science course such as: parental influence, high school teacher influence, whether students live on or off campus and other social activities.
6. Researchers who conduct studies at HBCUs or any school in which the population of students is not varied, must consider the role that homogeneity plays in the results.

Conclusions

The purpose of this research was to better understand factors that influence the achievement levels of non-science majors in Physical Science classes at a historically black college or university. The interest developed to better understand the relationship between various factors primarily gender, mathematics skills, reading comprehension and science reasoning as predictors of achievement in Physical Science based on personal observation and the literature itself. Secondarily, research interest was stimulated by the documented steady decline of African Americans in higher education as well as consistent issues with student retention rates at the research institution. In addition, because lack of achievement in science courses and science related courses had been associated with low socio-economic status, low potential for employability and lower wages once employed (Geary & Hamson, 2007).

The results of this research would be valuable to science educators, researchers, university faculty and administrators. Although the hypotheses in this research were not supported by the data, results indicate a need for further research into the relationships between science achievement and those factors that influence science achievement. Being that the majority of students who participated in the study were from one state, had similar high school backgrounds, had similar majors and were similar in age, the sample had more homogeneity than difference. Collecting data from several different HBCUs in different geographical locations with similar course descriptions and similar course requirements could provide different results. Recent studies have shown that African Americans tend to attend college in or near their home state due to economic constraints, which could account for homogeneity in the sample (Guess, 2007; Williams, Morris, &

Furman, 2007). In addition, the 93 students enrolled in Physical Science that chose not to participate in the study, could have provided more of a heterogeneous sample. This could provide different results than those found in this study.

APPENDIX A

PERMISSION TO USE HUMAN SUBJECTS

JACKSON STATE UNIVERSITY
1400 J. R. LYNCH STREET • JSU BOX 17057
JACKSON, MISSISSIPPI 39217-0157

THE OFFICE OF RESEARCH DEVELOPMENT
AND FEDERAL RELATIONS

PHONE: (601) 979-2931
FAX: (601) 979-3664

DATE: November 5, 2008

MEMORANDUM

TO: Consuella A. Davis
236 Lake Cove Drive
Jackson, MS 39212

FROM: Dr. Sophia Leggett
IRB, Chair

Re: Protocol entitled: "Gender, Mathematics, Reading Comprehension, and Science Reasoning as Predictors of Science Achievement Among African-Americans at a Historical Black College or University."

The Jackson State University Institutional Review Board (IRB) has reviewed your application and has come to the conclusion your responses are satisfactory and meet the requirements for protection of human participants as stipulated by the Federal government. Your application received an **Expedited** approval. This approval is good for **one year** from the date of this letter.

Any adverse reactions or problems resulting from this investigation must be reported immediately to the university Institutional Review Board. If you decide to modify or change your procedures in any way, please notify the IRB office in writing. We will review your request in the context of your complete application. If the changes are approved, you will receive written notification for the approval.

Any research that continues beyond one year should be resubmitted for approval before the end of each year so there is no lapse. Contact the IRB office for the extension form and the submission requirements before the end of October 2009.

Consent Short Form

THE UNIVERSITY OF SOUTHERN MISSISSIPPI
AUTHORIZATION TO PARTICIPATE IN RESEARCH PROJECT

(Short Form – to be used with oral presentation)

Participant's Name________________________

Consent is hereby given to participate in the research study entitled Gender, Mathematics, Reading Comprehension and Science Reasoning as Predictors of Science Achievement among African-American Students at a Historical Black College or University. All procedures and/or investigations to be followed and their purpose, including any experimental procedures, were explained by Ms. Consuella A. Davis. Information was given about all benefits, risks, inconveniences, or discomforts that might be expected. The opportunity to ask questions regarding the research and procedures was given. Participation in the study is completely voluntary, and participants may withdraw at any time without penalty, prejudice, or loss of benefits. All personal information is strictly confidential, and no names will be disclosed. Any new information that develops during the study will be provided if that information may affect the willingness to continue participation in the study. Questions concerning the research, at any time during or after the study, should be directed to Ms. Consuella A. Davis at (601)979-3614 or consuella.davis@jsums.edu. This research study and this consent form have been reviewed by the Human Subjects Protection Review Committee of the Office of Research and Federal Relations at Jackson State University, which ensures that research studies involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to contact Dr. Felix A. Okojie, Vice President of Research and Federal Relations, 601-979-2931.

APPROVED

NOV 05 2008

INSTITUTIONAL
REVIEW BOARD

Expires 11/04/2009

______________________________ ____________________

Signature of participant Date

______________________________ ____________________

Signature of person explaining the study Date

Dear Participant,

Have you ever participated in a research study? Have you ever wondered why there are fewer numbers of African Americans in science fields in comparison to other races? According to previous research, the earning potential of science, technology, engineering and mathematics (STEM) majors varies based on race and gender. According to the National Science Foundation, the median annual salary of employed full time scientists and engineers by the year 2003, including both genders, were from greatest to least: Caucasians who earned approximately $60,600, Asians who earned approximately $60,000, American Indian and Alaskan Natives who earned approximately $60,000, African Americans who earned approximately $53,500 and Hispanics who earned the least, approximately $47,000(NSF, 2008). In consideration to the median annual salary of men working as physical scientists in 2003, Caucasian men earned the highest median annual salary, earning approximately $65, 500. Asian men earned approximately, $64,000. American Indian and Alaskan Native men earned approximately $60,000. African American men earned approximately $55,400. Hispanic men earned the least with a median annual salary of $50,000 (NSF, 2008). Current research has also indicated that African-Americans presence in STEM fields is directly related to several factors including the gender of the individual, ability to reason scientifically, mathematics skills, and reading comprehension. I'd like to investigate whether or not the gender of the individual, mathematics ability, reading comprehension ability and science reasoning ability can influence achievement in a Physical Science class. Participation in the study is on a voluntary basis and will not affect your grade in this course. As a participant, you will be required to do the following: give written consent to use your ACT scores submitted to Jackson State University admissions office for college entrance, give written consent to utilize your midterm and final grades, complete a personal data survey sheet and be enrolled in Physical Science at Jackson State University during the semester the research is being conducted. Your midterm and final grades will be compared to your ACT scores in the research study. Completing the personal data survey sheet and written consent form should take about five minutes. Any questions that you do not want to answer, please leave it blank. The confidentiality of all participants will be protected. There are no direct benefits of participating in this study. The risks are very minimal. The personal data survey sheet and printed ACT scores will be kept in a locked cabinet that is only accessible to the researcher, Ms. Consuella Davis. When the study is complete the printed ACT scores and personal data survey sheet will be paper-shredded unless a written request is given to the researcher within 30 days after the completion of the study. If the participant desires to pick up the personal data survey sheet and printed ACT score, he or she must present proper identification to the researcher in the Jackson State University Department of Physics, Atmospheric Sciences and Geoscience within 30 days after the completion of the study. I would like to give your consent to participate in this research. If you choose not to participate, that's fine. This study has been reviewed by the Human Subjects Protection Review Committee of the Office of Research and Federal Relations at Jackson State University, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research participant should be directed to Dr. Felix A Okojie, Vice President of Research and Federal Relations, 601-979-2931.

Thanks for all of your help.

Sincerely,

Consuella A. Davis

APPROVED
NOV 0 5 2008
INSTITUTIONAL
REVIEW BOARD
Expires 11/04/2009

____
Signature of person giving oral presentation

JSU-ORA-IRB-4-06

APPENDIX B

PERMISSION TO USE HUMAN SUBJECTS

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

TO: Consuella Davis
236 Lake Cove Drive
Jackson, MS 39212

FROM: Lawrence A. Hosman, Ph.D.
HSPRC Chair

PROTOCOL NUMBER: 28100601
PROJECT TITLE: Gender, Mathematics, Reading Comprehension and Science Reasoning as Predictors of Science Achievement Among African-American Students at an Historically Black College or University

Enclosed is The University of Southern Mississippi Human Subjects Protection Review Committee Notice of Committee Action taken on the above referenced project proposal. If I can be of further assistance, contact me at (601) 266-4279, FAX at (601) 266-4275, or you can e-mail me at Lawrence.Hosman@usm.edu. Good luck with your research.

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months. Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **28100601**
PROJECT TITLE: **Gender, Mathematics, Reading Comprehension and Science Reasoning as Predictors of Science Achievement Among African-American Students at an Historically Black College or University**
PROPOSED PROJECT DATES: **10/12/08 to 12/31/08**
PROJECT TYPE: **Dissertation or Thesis**
PRINCIPAL INVESTIGATORS: **Consuella A. Davis**
COLLEGE/DIVISION: **College of Science & Technology**
DEPARTMENT: **Center for Science and Math Education**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **10/20/08 to 10/19/09**

Lawrence A. Hosman — 10-22-08

Lawrence A. Hosman, Ph.D. — Date
HSPRC Chair

APPENDIX C

SYLLABUS FOR PHYSICAL SCIENCE COURSE

Fall 2008

Physical Science, by Bill W. Tillery, Seventh edition (no other editions are acceptable)

Course Description and Learning Objectives:

In this course, you will learn the basic principles of matter and energy and their applications. This course is designed primarily to accommodate the needs of non-science majors who are required to complete the course. Secondarily the course is designed to enhance the constructive knowledge of science majors who may take the course as an elective. Materials presented in this course are created to support a conceptual approach through problem solving and application to real life situations. You will be graded mainly on your ability to solve problems and your ability to apply understanding of the concepts presented from each of the areas of science listed below. You are encouraged to attend every class, listen carefully, take notes, read over the material prior to class and ask informed questions in the class.

There are two basic requirements for your study of Physical Science:

(a) Physical Meaning: Make sure that you understand the physical meaning of each concept, each term, and the relationships of one concept to another.

(b) Application: Make sure that you are able to solve the homework problems using formulas and principles you have learned in the class. When you read the examples in the book, try to solve them before you read the solutions.

Bring your binder, syllabus, textbook, and a pencil to every class!

Instructional Strategy:

These will include (but are not limited to)

1. Lectures
2. Discussions/Questioning
3. Problem Solving
4. Evaluations and Testing

Evaluation of students will be based on the performance of the students on quizzes, tests, homework assignments, laboratory exercises, projects, group assignments and attendance in class

Calculator:

You are <u>not allowed</u> to use calculators during tests or quizzes.

Attendance: Attendance in class is required. It is your responsibility to find out the material and the announcements should you miss class (es).

Study Hours per Week:

Usually, a person would not do more than 6 hours of work outside of class per week. Physical Science is considered an average course, so it might be best to study the proposed 9 hours a week. If more hours are needed, take away some hours from easier courses, i.e., basket weaving.

Labs: Labs will be announced. All reports must be typed and turned in on the scheduled date set by the instructor. There is no makeup for missed labs.

Projects:

One project will be given on a selected topic within the course. A rubric will be given to accompany each project. See the attachment.

Homework:

Homework assignments are to be completed individually and are attached to the syllabus. Due dates have already been set. Adhere to the assignment guidelines for submitting homework assignments. I will not remind student to turn in their homework. Deductions will be made for non-adherence to the guidelines.

You will be given opportunity to ask questions about problems during class. You are also encouraged to work together with other students on the problems, but you must complete your homework independently and never copy others.

Hour Tests:

There will be four scheduled tests, the lowest of which will be dropped. The format for the questions is multiple choice. Tests will be given at the end of each instructional block (see attached outline). Time allotment is one class session (one hour) for testing (reserved for instructor amendments). No one will be allowed to take the test at a later time. These tests are closed - book and closed - notes. You will not be provided with a formula sheet. You must have a scantron version 882e answer sheet for every test. It is green and white and shaded on one side. No other answer sheet is acceptable.

Test 1----------------------------Chapters: 1-4

Test 2----------------------------Chapters: 17-21

Test 3----------------------------Chapters: 14-16

Final----------------------------Chapters: 1,2,3,8, 9, 10,14,15,16, 17, 18, 19, 21,22, 23, and 24

Midterm:

There will be no midterm exam. Midterm grades will be reported on the basis of the average of the quizzes and any test given before the due date for midterm grades.

Final:

The final examination will be on __________ at your regular class time unless otherwise indicated by the instructor. The final exam will be comprehensive. (*Note that this test date is different from the date published in the Class Schedule Booklet.*)

Final exam will include:

25%----------------------------Chapters: 1, 2, 3, & 4

25%----------------------------Chapters: 14, 15, 16, 17, 18, 19 &21

50%----------------------------Chapters: 8, 9, 10, 22, 23, & 24

Makeup Tests:

No makeup tests will be allowed in this course.

Checkpoint Quizzes:

Checkpoint quizzes are designed to test the student's comprehension, listening and study skills. Quizzes will be administered either at the beginning or at the end of class. There will be approximately 3 quizzes. Your lowest score will be dropped. Please note the following:

(a) Quizzes are closed-book and closed-class note exams.
(b) You are not allowed to communicate with others during the quiz.
(c) You will be given 5 to 10 minutes for each quiz.
(d) If you miss the quiz, you will not be allowed to make it up.

Methods of Grading:

The points accumulated in the requirements listed below determine the quality of your grade. The points are assigned as follows:

1. Class participation (includes attendance, group activities, group projects)
Ten points will be deducted for every unexcused absence or any absence beyond three excused absences. 10%
2. Exams including Final 40%
3. Lab Write-ups 10%
4. Project 15%
5. Homework 15%
6. Checkpoint quizzes 10%

Grading Scale:

A .... 89.5 – 100
B .... 79.5 – 89
C .... 69.5 – 79
D .... 59.5 – 69
F .... 0 – 59

Disabled Students Statement:

Students or employees with disabilities are offered a variety of services and resources through the ADA Coordinator for students, and employees, and campus visitors with disabilities. Students or employees with documented disabilities such as hearing impairments, visual impairments, learning disabilities, and mobility impairments are eligible for services. Support Services, a component of the Office of the President, coordinates such services as registration assistance, tape recorded texts, testing accommodation, attendants referrals, and academic advice. The ADA Coordinator also works closely with the state department of rehabilitation services and other organizations to assist students with disabilities.

Cell Phones/Beeper/Pagers/etc.:

If a cell phone/beeper/pager or any other annoying device that is in your possession goes off while you are in class during the class period, you will lose one letter grade, regardless of the circumstance. You will lose an additional letter grade each additional time the device goes off. If this is going to be a problem, please turn off or set your device to silent/vibrate mode before you enter the classroom. If your phone vibrates during the class meeting just leave the classroom to attend to the call. If I can not detect whose phone rang, and no one admits to it, everyone in the "area" of the call will lose one letter grade (until someone admits to the discretion.)

E-mail Addresses:

Please make sure that I can E-mail you at your HBCU E-mail address. Email addresses are assigned to students and are activated 24-48 hours after registration. Use the following link to get instructions: http://webmail..edu/Email_Info/Email_For_Students.pdf. The format for Official University email addresses is as follows:
firstname.mi.lastname@HBCUms.edu or firstname.lastname@HBCUms.edu
If I have to contact you, I will go to the HBCU web page and look up your HBCU E-mail address and send you the message through this address. If you do not use this E-mail address, I suggest you forward the E-mail sent to your HBCU address to wherever you currently get your E-mail – which you should have done anyway.

Get access to your email
Follow these three steps to get access to your email:

- Find out what your email address, Alias and NetID are.
- Activate your NetID.
- Login to HBCU Webmail.

FIND OUT YOUR EMAIL ADDRESS
1. Login to your HBCU
2. Click the "Personal Information" bar.
3. Look for the "View E-mail Address" Link.
4. You will see "University Students Alias Email Address" and a "University Student Email Address".
-The Alias is what you can give other people so that they can email you; this is in the format of firstname.mi.lastname@students.hbcu.edu.
-The University Student Email Address (in the format of p00012345@students.hbcu.edu) is what HBCU will use to email you official information.
5. Either the alias or the email address will work to receive email; however, you always have to login to the webmail using your NetID/Jnumber and NetID Password.
Two options to Activate your NetID
OPTION 1:
1. Open Internet Explorer.
2. Visit http://143.132.24.6/TSWeb.
3. Add the above link to your trusted sites.
4. Click on tools > Internet Options > Security TAB > Trusted Sites > Sites > it will show http://143.132.24.6 > click on add > refresh the page.
5. At this point you will see a logon screen.
6. Login using your NetID (p Number) and your six digit P.I.N. followed by @HBCU <e.g., 123456@HBCU> (same username and password that you use to login to HBCU account).
7. You will be prompted to change your password; proceed to change it (the new password must contain at least 8 characters, one digit and a symbol).
8. You are done activating your NetID.
OPTION 2:
1. Click on Start button on the desktop > all programs > Accessories > Remote Desktop > Connection.
2. Enter IP address 143.132.24.6 and click on connect.
3. At this point you will see a logon screen.
4. Login using your NetID (Number) and six digit P.I.N. followed by @HBCU <e.g., 123456@HBCU> (same username and password that you use to login to HBCU account).

5. You will be prompted to change password; proceed to change it (the new password must contain at least 8 characters, one digit and a symbol).
7. You are done activating your NetID. – NOTE: Visit http://lab.HBCUstate.edu/site/faq/logon.pdf for more info.
Login to your webmail:

- *Go to http://www.HBCUstate.edu*
- *Under the "Select Webmail Server" option, choose students.HBCUstate.edu.*
- *Click the "Go To Login" button.*
- *Type your NetID and the Password that you just created.*
- *You are done.*

For questions or help about NetID, please call ______________.

Tentative Order of Class Sessions:

Day	Date	Activity
		1st Day of classes Course Introduction Syllabus Discussion
		Chapter 1-What is Science? Chapter 2 Begins-Motion Quiz 1 Last Day to Add a Course
		Complete Chapter 2-Motion Chapter 3-Energy Chapter 4 Heat Homework Assignment 1 Due *Quiz 2* Last Day to Drop a Course *Project 1 Due* Lab 1 Due Group Presentations of Lab #1 *Test 1*
		Chapter 17-Rocks and Minerals Chapter 19-Building Earth's Surface Chapter 18-Plate Tectonics Chapter 21-Geologic Time Homework Assignment 2 Due Quiz 3
		Midterm Exams-Test 2 Midterm Exam Week
		Lab 2 Due *Group Presentations Lab #2*
		Last Day to Drop with a "W" Grade Chapters 14-The Universe Chapter 15-The Solar System Chapter 16-Earth in Space *Homework 3 Due today* *Test #3*

Schedule of Classes Continued	Chapter 22-The Atmosphere of Earth
	Chapter 23-Weather and Climate
	Chapter 24-Earth's Waters
	Homework Assignment 4 due today
	Lab #3-In Class Demonstration/Due
	Chapter 8-Atoms and Periodic Properties
	Chapter 9-Chemical Properties
	Chapter 10-Chemical Reactions
	Final Review
	Last Day to Withdraw from the University
	Final Examination

Homework Assignments (varies each semester)
SCI 201

Assignments Number	Assignment	Due Dates
	Guidelines: Write a minimum of 4 paragraphs(not to exceed 6) using the said guidelines; must be typed in black ink, size 12 fonts, double spaced, running head on all pages that includes the title and your name, cover page must be included, must be in a report jacket, 3 references(one internet source allowed)	
1	Creation and Evolution	
2	The Geological History of the state during the Paleozoic Era to present day	
3	Legislative Efforts and the Politics of Global Warming, What is the Platform Perspective of Each Presidential Candidate	
4	Trace the Invasion of the Snakehead Catfish in American Water Systems(Where did it come from and how did it get here(include but do not limit yourselves to this only)	
NO EXCUSES!!	NO EXCEPTIONS!!	NO ALIBIAS!!

Attachment 1

Name:_______________________________________

Date:________________________

RUBRIC FOR PROJECT
Possible points 105 pts.

Directions: Use a scrapbook to create a collage that includes images of numbers 1-15 in the order listed below. Only 1 image should be used per page. Images 1-15 must not be duplicates of each other. Give brief explanations telling why you chose the specific picture (from a book or magazine) to represent numbers 1-15, typed under the picture. Also include a copy of this sheet on page 1 of the scrapbook with your name on it. Only use images that appear in color, black and white images are not acceptable.

1. Defines me and who I am today
2. Something good
3. Something bad
4. Something that makes me happy
5. Something sad
6. Something hard
7. Something soft
8. A pretty color or design
9. Reminds me of my childhood
10. Something complicated
11. Something or someone smart
12. Something unique
13. A scientist
14. Good music
15. My future(this is you, not me)

Attachment 2

Physical Science 201 Lab #1 Instruction Sheet
Instructor

Name:________________________ Date:________________________

Scientific Process Skills Used: Observing, Classifying, Communicating, Interpreting, and Experimenting, Predicting and Inferring

Working in groups the students will choose two of the following trees found in our state:

1. Red Buckeye
2. Rough Leaf Dogwood
3. American Elm
4. Flowering Dogwood
5. Hawthorne
6. Hackberry
7. Rusty Black Haw
8. Mexican Plum
9. White Ash
10. Chinkapin
11. Cherry Bark Oak
12. Long Leaf Pine
13. Short Leaf Pine

The student will research and report all of the following on a poster board:

1. Common name
2. Scientific Name
3. Family Name
4. Picture of trees
5. Three facts about the tree other than what is required for the lab
6. Where is it geographically located?
7. Is it indigenous to our state?
8. Medicinal values
9. Compare and contrast to another tree (can be your other pick)
10. Five minute group presentation consisting of all of the above

An example for your poster board layout is outlined below. Your poster does not have to be identical to the one below, but should be similar. Remember to include the date, course and section numbers.

Flowering Dogwood
Lab #1
Group Members

__________ __________
__________ __________

Photo

1. 2.

3. 4. etc.

Attachment 3

Physical Science 201 Lab #2 Instruction Sheet
Name:____________________________ Date:____________________

Lab #2 : Understanding Earth's Changes Over Time

Introduction
Comparing the magnitude of geologic time with spans of time in a person's lifetime is difficult for many people. In this activity, you will use a long paper strip and a reasonable scale to represent virtually all of geologic time, including significant events in the development of life on earth as well as recent human events.

Materials and Equipment
The following materials will be needed by each group of two students:
• A paper strip, such as adding machine or cash register tape,
• A meter stick,
• A calculator,
• Colored pencils,
• Evolutionary/Geologic Timeline

Directions
Use the materials described above to plot a model of earth's changes over time. Be sure to perform the following tasks:
• Calculate a scale that can be used to display the events on the timeline (make sure your scale is used in a legend on the model); limit your scale to NO MORE than 16 meters long
• Have a title for your model;
• Use colored pencils to plot the events and use an icon of some sort to visually depict the events on your model (e.g., a lizard drawing to represent the rise of the reptiles) NOTE: you will diagram only some of the events----see Evolutionary/Geologic Timeline sheet below

See the following pages for Lab #2

EVOLUTIONARY/GEOLOGICAL TIMELINE
Time (Millions of years ago) Event
PART A-DO 5(1A-8A)

SECTION A

1A. 4600 Formation of the approximately homogeneous solid Earth by planetesimal accretion
2A. 4300 Atmospheric water is photodissociated by ultraviolet light to give oxygen atoms which are incorporated into an ozone layer and hydrogen molecules which escape into space
3A. 3800 The Earth's crust solidifies---formation of the oldest rocks found on Earth

4A. 3800 Condensation of atmospheric water into oceans
5A. 3500--2800 Prokaryotic cell organisms develop
6A. 3500--2800 Beginning of photosynthesis by blue-green algae which releases oxygen molecules into the atmosphere and steadily works to strengthen the ozone layer and change the Earth's chemically reducing atmosphere into a chemically oxidizing one
7A. 1500 Eukaryotic cell organisms develop
8A.1500--600 Rise of multicellular organisms (Cambrian explosion)

DO EVERY OTHER EVENT IN SECTION B (DO NOT EXCEED 4)SECTION B

1B. 545 Cambrian explosion of hard-bodied organisms 500--450 Rise of the fish---first vertebrates

2B. 430 Waxy coated algae begin to live on land

3B. 420 Millipedes have evolved---first land animals

4B. 375 The Appalachian Mountains are formed via a plate tectonic collision between North America, Africa, and Europe

5B. 375 Appearance of primitive sharks

6B. 350--300 Rise of the amphibians

7B. 350 Primitive insects have evolved
8B.350 Primitive ferns evolve---first plants with roots
9B. 300--200 Rise of the reptiles
10B. 300 Winged insects have evolved
11B. 280 Beetles and weevils have evolved
12B. 250 Permian period mass extinction
13B. 230 Roaches and termites have evolved
14B. 225 Modern ferns have evolved
15 B. 225 Bees have evolved
16B. 200 Pangaea starts to break apart
17B. 200 Primitive crocodiles have evolved
18B. 200 Appearance of mammals
19B. 145 Archaeopteryx walks the Earth
20B. 136 Primitive kangaroos have evolved
21B. 100 Primitive cranes have evolved
22B. 90 Modern sharks have evolved
23B. 65 The Chicxulub impact occurs
24B. 65 K-T Boundary---extinction of the dinosaurs and beginning of the reign of mammals

25B. 60 Rats, mice, and squirrels have evolved
26B. 60 Herons and storks have evolved

27B. 55 Rabbits and hares have evolved
28B. 50 Primitive monkeys have evolved
29B. 28 Koalas have evolved
30B. 20 Parrots and pigeons have evolved
31B. 20--12 The chimpanzee and hominid lines evolve
32B. 4 Development of hominid bipedalism
33B. 4--1 Australopithecus exist
34B. 3.5 The Australopithecus Lucy walks the Earth
35B. 2 Widespread use of stone tools
36B. 2--0.01 Most recent ice age
37B. 1.6--0.2 Homo erectus exist
38B. 1--0.5 Homo erectus tames fire
39B. 0.2--0.03 Homo sapiens neanderthalensis exist
40B. 0.05--0 Homo sapiens sapiens exist
41B. 0.04--0.012Homo sapiens sapiens enter Australia from southeastern Asia and North America from northeastern Asia
42B. 0.025--0.01 Most recent glaciation---an ice sheet covers much of the northern United States
43B. 0.017 Homo sapiens sapiens paint the Lascaux cave
44B. 0.01 First permanent homo sapiens sapiens settlements
45B. 0.01 Homo sapiens sapiens learn to use fire to cast copper and harden pottery
46B. 0.006 Writing is developed in Sumeria
47B. 0.0046 Oldest known Pine tree starts to grow

DO ALL 4 BELOW LINE(1C-4C)
SECTION C

1C. First U.S. satellite orbited, 1958
2C. First man on moon, 1969
3C. The year you began high school.
4C. Today.

All together when you are finished with this lab, you should have 13 events. Work with your group members on this lab.

HBCU NAME
Office of Academic Affairs

Verification of Enrollment
Receipt of Syllabus

Please complete the information requested below and return this form to the instructor.

Name: HBCU ID-Number:

Course No./Section: Course Title:

Semester: Year:

(Seal of HBCU)

I acknowledge the receipt of a syllabus for the above course.

______________________________ ______________________

Signature Date

Student Understandings

(Read and initial each blank and sign your name at the bottom of the page).

1. I understand that there are intellectual standards in this course and that I am responsible for monitoring my own learning.____________
2. I understand that if at any time in the semester I feel unsure about my "grade", I may request an assessment from the instructor(s). ____________
3. I understand that there is a final exam in the course and that it is not at the scheduled time as stated in the class schedule booklet. ____________
4. I understand that the work of the course requires consistent classroom attendance and active participation.________
5. I understand that the class will not be graded on a curve. I understand that it is possible, theoretically, for the whole class to earn a grade of A or F. ____________
6. I understand that the basis of the final grade as outlined in the syllabus. ____________
7. I understand that reading and homework is to be done prior to class. ____________
8. I understand that there is a "<u>NO MAKE UP POLICY</u>", on tests are quizzes. ____________
9. I understand that I must bring all appropriate materials to each class.________
10. I understand that the final exam is on_________ at the scheduled class time and that this is not the time scheduled in the Class Schedule Booklet. ____________
11. I understand that homework, projects and labs will not be accepted after the due date.______________
12. I understand that I must adhere to the academic dishonesty outlined in the student handbook_____________
13. I understand that I will not be granted permission to take another exam during my scheduled class time.___________
14. I understand that it is my responsibility to have a scantron version 882e answer sheet for every test. ____________
15. I understand that library days are given to complete group assignments and projects and should never be considered as a day off____________.

______________________________________ ________________________

Signature Date

APPENDIX D

PERSONAL DATA INFORMATION SHEET

Instructions: Circle the most appropriate response

Sex: Male Female

Race: African-American White Asian Hispanic Other

Current Age: 18-19 20-21 22-23 24-25 Other

Major: Science Non-science

In which state did you attend high school?

High School: Public Private

If private, was the school religious based? Yes No

High School: Urban Suburban Rural

High School Size: Under 100 101-500 501-1000 Over 1000

Number of science courses taken: 1 2 3 4 or more

Grade you expect to earn in Physical Science: A B C D F

Circle all math courses that you took in high school:

Algebra I Algebra II Geometry Trigonometry Calculus Other

Circle all science courses that you took in high school:

Biology Chemistry Physics Physical Science Other

Circle all Language Arts courses that you took in high school:

Literature Journalism Learning Strategies English (how many parts)__ Other__

Employment: Full-time Part-time Student Worker None

Do you have children? Yes No

On average, how many hours per week do you study Physical Science?

Less than 1 hour 1 to 2 hours More than 2 hours

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