SCIENCE INTERVENTION PROGRAMS FOR SOUTHERN BLACK STUDENTS: A CLUSTER EVALUATION AND TWO PROPOSED MODELS

By

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This dissertation is dedicated to all the children I have known and will know.
This study reflects my commitment to you.

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This study investigated science intervention programs for Black students in South Carolina, Georgia, and Maryland. The sample consisted of five programs that aim to increase the participation of Blacks in science via after-school, Saturday, and summer experiences. These long-term programs offered a variety of experiences, including hands-on science activities, contact with mentors and role models, exposure to science-related careers, and opportunities to increase science content knowledge and improve science process skills. Artifact data, a Program Coordinator Questionnaire, site visits, and interviews were used to identify and describe five existing science intervention programs for Black students.

The study proposed a set of standards for science intervention programs for Black students. These standards addressed eight components of programs, including objectives, format, location, target population, recruitment and selection, intervention activities, staff, and financial information. Using a modified approach to cluster evaluation, the five

programs were compared to the standards. This evaluation revealed the strengths and underlying weaknesses of the cluster that informed the development of two models for future science intervention programs.

Though implemented in numerous ways, the cluster's strengths included sound, measurable objectives; articulation of program objectives to staff, participants, and parents; frequent contact during sessions; the potential for continuous involvement of staff and participants; the inclusion of a range of student achievement levels; programs that served their target group; the representation of various communities, neighborhoods, and schools; effective recruitment strategies; financially inclusive programs; a variety of intervention activities; intensive training for staff; and substantial staff compensation.

Three major shortcomings of the cluster were identified as inadequate focus on science-related careers and science process skills; poor use of communities as sites for doing and seeing science; and meager intervention strategies for younger students. These shortcomings perpetuated underlying inequities of knowledge and power, despite the well-intended science intervention efforts.

This study identified and described several science intervention programs, developed standards for implementing and evaluating science intervention programs, and proposed two models for future programs. In light of current efforts to make science for all students by the year 2061, the value of these contributions is high.

CHAPTER 1
INTRODUCTION

Traditionally, it has been believed that knowledge is power (Sleeter & Grant, 1991). Science is knowledge, thus science is power. For years, science has been the domain of White men, and has been deemed hard, complex, and only for the most intelligent. Under this premise, if the holders of science knowledge (i.e., White males) have power, then those without the knowledge (i.e., women and minorities) are powerless and subject to oppression (Baptiste, 1989).

In recent years, American society has noticed the underrepresentation of women and minorities in the quantitative sciences. The systemic vices (i.e., tracking, apathetic teachers, unprepared teachers, ill-equipped classrooms, poor funding) leading to this underrepresentation have also been acknowledged (Atwater, 2000; Chenoweth, 1999; Clark, 1999; Oakes, 1985; Slate & Jones, 1998). Those in power have realized the damage this unequal participation can do to the United States—reducing the nation's competitive edge—and consequently have pledged to make science accessible to all students (Miller, 1995; Rutherford & Ahlgren, 1990). A number of intervention programs has been established to increase female and minority participation in the sciences. These programs attempt to reach the untapped potential along the educational pipeline with the hopes that these groups will eventually choose science-related careers.

A study of intervention programs for girls and minorities found that most programs do not exist in the region of the country (i.e., the South) that houses the majority of the U.S. Black population (Clewell, Anderson, & Thorpe, 1992b). If the fewest intervention efforts occur where most Black students live, clearly a great deal of science potential is being overlooked and left untapped. According to the 2000 U.S. Census (U.S. Census Bureau, 2001), the South remains the region of the country with the highest percentage of the Black population. The South Atlantic sub-region (Delaware, Maryland, Washington, D.C., West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida) contains a larger portion of Black people than any other sub-region in the South. Within the South Atlantic, Washington, D.C. (60%), South Carolina (29.5%), Georgia (28.7%), and Maryland (27.9%) have the largest proportions of Blacks relative to their individual populations. These three states and the District of Columbia contain 42 publicly funded universities, nine of which are historically Black. State universities have a fundamental interest in the state's populace to produce as many thinkers, creators, educators, and researchers who ideally will remain in the state, and a mission to make education more accessible to the public. Recently, this has involved more community interaction and outreach, some of which has been in the form of science intervention programs for minority students. An investigation of science intervention programs for Black students that are administered by state universities in the South can provide insight into the meanings of current efforts to make science for all students.

Statement of the Problem

> Knowledge is central to power. Knowledge helps us envision the contours and limits of our existence, what is desirable and possible, and what actions might bring about the possibilities. Knowledge helps us examine relationships between what is ethical and what is desirable; it widens our experiences; it provides analytic tools for thinking through questions, situations, and problems. Empowering knowledge centers on the interest and aims of the prospective knower. Apart from the knower, knowledge has no intrinsic power. (Sleeter & Grant, 1991, p. 50)

The above quote illustrates the tremendous effect of knowledge. If knowledge yields power, then those who understand and generate new knowledge are endowed with much power. This scenario applies to all forms of knowledge, including science knowledge. Baptiste (1989) argues that science knowledge is socially distributed in U.S. classrooms, thus providing one group of students (i.e., White males) access to power and its benefits, while other groups (i.e., minorities and females) remain powerless and subject to oppression.

Historically, science in the United States has been described as a White male endeavor. The sciences, particularly mathematical sciences, have been deemed as selective and elitist in nature. This exclusivity has resulted in monolithic answers to common questions about science—What is science? Who does science? What counts as science knowledge? Ever since the Russians launched Sputnik in the 1950s, the United States has realized its scientific/technological vulnerability (Carin & Bass, 2001). Subsequent international tests in math and science continue to expose the country's inability to be a top academic competitor with other developed nations (National Center for Education Statistics, n.d.a; n.d.b). This prompted the scientific and educational communities to recognize the untapped scientific potential found in women and minorities, as well as the systemic vices (i.e., tracking, apathetic teachers, ill-equipped classrooms, poor funding) leading to the underrepresentation of these groups (Atwater, 2000; Chenoweth, 1999; Clark, 1999; Oakes, 1985; Slate & Jones, 1998). A pledge to make science literacy for all, introduced in *Science for All Americans* (Rutherford & Ahlgren, 1990) and subsequently described in *Benchmarks for Science Literacy* (American Association for the Advancement of Science [AAAS], 1993), has resulted in a number of intervention programs designed to increase female and minority participation in the sciences.

Females and Minorities in Science

Despite the emphasis on science for all students, minorities and females continue to be underrepresented in science (Catsambis, 1995; Clark, 1999; Kahle & Lakes, 1983; Oakes, 1990). The reason can be described in terms of a game. To play any game, it is necessary to understand its rules. Those players who lack an understanding also lack an equal opportunity to win the game. Females and minorities have an unfair disadvantage because they neither helped establish nor understand the rules associated with the game of science. To win (or at least have a chance to win) females and minorities must learn and understand the rules (Monhardt, 2000). Teachers have the task of teaching the rules to their students, but the task becomes complicated by a number of factors. Clewell, Anderson, and Thorpe (1992a) view these factors as barriers to female and minority participation in the sciences that include negative attitudes and perceptions of science, poor academic performance, insufficient course and extracurricular participation, and limited knowledge of related professions.

Gender differences in attitudes toward science begin to appear during middle school and become fixed by the end of high school (Oakes, 1990). Boys are more likely than girls to consider science useful and applicable to everyday life (Kahle & Lakes, 1983). Furthermore, sixth grade girls tend to have fewer experiences with, and less interest in, science than boys, particularly the physical sciences (Jones, Howe, & Rua, 2000). These circumstances may be a cause of the performance anxiety found in female science students. Interestingly, although eighth grade girls score significantly higher than boys on science achievement tests, they hold more negative attitudes toward science than their male counterparts (Catsambis, 1995). Students' participation in science-related extracurricular activities strongly indicates their interest in science. Among all students, African American students report the highest levels of participation in extracurricular science activities (Catsambis, 1995), despite low scores on science achievement tests. Other studies (reported in Kahle & Lakes, 1983) note the low participation of African American and female students in extracurricular science activities. These achievement-attitude contradictions of females and minorities indicate that the development of gender and race/ethnicity differences in attitudes toward science occur independently of achievement levels. These studies suggest that a phenomenon may be occurring in schools to discourage positive attitudes toward science among females and minority students.

Mondhart (2000) describes the common practice of grouping minority students together and negatively labeling them. In 1996, 29% of high school classes with few minority students were labeled low ability, while 42% of high school classes with at least 40% minority students were labeled low ability. Though most teachers are female, 92% of science teachers in grades 7-12 are White, 5% are African American, and 3% represent other ethnicities (Bradley, 1997). These statistics may seem meaningless without a consideration of the cultural baggage teachers bring to science classrooms.

Differential treatment in the way science content is presented in daily instructional activities exists in U.S. schools (Atwater, 2000; Contreras & Lee, 1990; Kahle, Parker, Rennie, & Riley, 1993). Teachers of high performing students allow their students better access to science content by spending a critical amount of time on instructional activities, presenting relatively more content knowledge, and offering support and attempting to motivate students. On the other hand, teachers of low performing students reportedly spend more time dealing with classroom management issues (Contreras & Lee, 1990). African American boys make up a disproportionate number in academically less-challenging classes, while White students largely populate more-challenging classes (Catsambis, 1995). Furthermore, minority students face unqualified science teachers more than their White counterparts. Teachers with low expectations of their Black students consciously and unconsciously impart these perceptions, which in turn lead to students' low expectations of themselves. This self-fulfilling prophecy results in a group of students who believe they are unable to learn the rules of the science game (Monhardt, 2000). The dearth of female and minority science role models (e.g., teachers, older students, and scientists) further compounds the problem by inadequately illustrating the achievements of females and minorities in science. Consequently, student-centered intervention programs aim to relieve the burdens that minimize female and minority participation in the sciences.

Intervention Efforts

Student-centered intervention efforts include in-school, after school, weekend, and summer programs. These programs target a number of grade and achievement levels, and focus on any combination of science skills, knowledge, careers, and attitudes: "Since intervention programs [arise] out of the recognition that formal education [fails] to address the problem of low minority and female representation in [science] careers, it is logical that the programs [utilize] approaches somewhat different from those of the traditional educational system" (Clewell, Anderson, & Thorpe, 1992a, p. 13). Clewell et al., (1992a) have conducted the only comprehensive review to date of science, math, and technology intervention programs for female and minority students in grades four through eight. Of the 163 programs throughout the U.S. that satisfied their criteria, 54% targeted both females and minorities, whereas 13% and 33% target only females and minorities, respectively. Sixty-seven percent of the programs actually served female students, while 88% served minority students. Of all ethnic groups, Blacks (83%) were served more than any other group. The vast majority of the programs (64%) focused on science, math, and technology, while 17% of the programs focused on science only. The study found a positive relationship between increasing grade level and number of programs. As grade level increased from four to eight, more programs existed. The geographic distribution of the intervention programs within the U.S. was interesting. The West [had] the greatest number of programs (30%) followed by the Northeast (28%), then by the Central states (24%), and the Southeast (18%). The top five states for programs were [California, New York, Georgia, Illinois, and Washington, D.C.]" (Clewell et al., 1992b, p. 211). While the preponderance of science intervention programs in some states/regions and the dearth of programs in others cannot be explained, it is clear that Black and Native American students remain underserved by current efforts (Clewell et al., 1992b).

The variety of current efforts to increase female and minority participation in science classes and science-related careers can be viewed as bandage approaches that merely aim to quiet concerned voices without actually changing the sociocultural structure that nurtures the conditions to allow for underrepresentation. On the other hand, intervention efforts can be perceived as good faith efforts to reverse the ills of marginalized females and minorities in science.

Project 2061

In an effort to reform U.S. science, mathematics, and technology education, the American Association for the Advancement of Science (AAAS) initiated Project 2061. This project was designed to help the nation achieve science literacy for all Americans (AAAS, n.d.). The long-range effort began in 1985, the last time Comet Halley visited the earth's vicinity. The goals of the initiative are to be accomplished by the year of Comet Halley's next visit, year 2061.

Realizing that all Americans are not science-literate and that U.S. students consistently rank poorly on international science and mathematics exams, Project 2061 is based on the following convictions (AAAS, n.d.): (a) all children need and deserve a basic education in science, mathematics, and technology that prepares them to live interesting and productive lives; (b) world norms for what represents a basic education have changed in response to the growth of scientific knowledge and technological power; (c) U.S. schools have not taken enough steps to prepare young people—especially minority children—for a world shaped by science and technology; (d) systemic changes in the kindergarten through twelfth grade (K-12) educational system will have to be made to achieve science literacy for all Americans; and (e) reaching a clear understanding of what constitutes science literacy is the first step to achieving that goal.

As a long-term initiative, Project 2061 has three phases (AAAS, n.d.). The already completed Phase I established a conceptual base for reform. *Science for All Americans*, the product of Phase I, defines the science knowledge, skills, and attitudes that all students should gain as a result of their K-12 matriculation. Panels of renowned scientists, mathematicians, and engineers worked together to develop this book. Phase II, scheduled to end in 1992, devised a variety of science literacy curriculum models to be used by school districts and states. Phase II also described the characteristics of other areas that supplement the new curricula, such as teacher education, testing policies and practices, technology and new materials, the organization of schooling, state and local policies, and research. This phase involved collaborative work between scientists and educators, and resulted in so-called blueprints for reform. The final phase involves various affiliations (i.e., scientific societies, educational organizations and institutions, and other groups) working to transform the blueprints into educational practice.

Equity issues remain major challenges in the quest for science literacy for all Americans (AAAS, 1997). Reformers seek to make science understandable, accessible, and even enjoyable for all K-12 students. Traditionally, while all students had been expected to learn reading and math, science had been accessible only to privileged students. Groups of students who are currently underrepresented in science classes and science-related careers include females, African Americans, Hispanic Americans, American Indians/Alaskan Natives, students with disabilities, and English language learners. Additionally, socioeconomic status largely affects students' achievement in school. As a result, Project 2061 believes: "Young people of all abilities, ethnicities, and backgrounds will be less likely to participate in math and science if they express low confidence in their abilities to master mathematics and science and to succeed in careers requiring these skills; if they value success and participation in these fields less than they value success and participation in other fields; if they do not enjoy mathematics and science; and if they experience a nonsupportive environment for learning mathematics and science, either in school or at home. Therefore, it is particularly important to remedy these conditions for groups that are already underrepresented in mathematics and science" (AAAS, 1997). As funding agencies and government entities dole out monies to create programs and services to make science for all, they require formative and summative evaluations of those endeavors. To date, no individual or organization has attempted to evaluate the progress of the overall initiative as it relates to science intervention for Black students.

Purpose of the Study

This study was designed to investigate existing, publicly administered science intervention programs for elementary through high school Southern Black students. Using data from print materials, site visits, questionnaires, and interviews, the study identified implicit patterns that represent the nature of efforts to achieve the goal of Project 2061—science literacy for all. The exploratory nature of this study precluded any attempts to generalize the results to programs other than the ones represented. Additionally, the study utilized the strengths and weaknesses of existing science intervention programs to inform the development of two models for new and/or modified programs. This study investigated science intervention programs for Southern Blacks as represented by the five programs in the cluster. Additional research is required to corroborate the findings of this study, particularly as they pertain to other science intervention programs and the larger initiative, science for all.

Research Questions

The research answered the following questions:

1. What science intervention programs do Southern state universities offer Black elementary through high school students in an effort to make science for all?
    a. What are the objectives of the programs?
    b. What are the formats of the programs?
    c. Where do the programs occur?
    d. What populations do the programs target?

   e. How are participants recruited and selected?
   f. What types of intervention do the programs provide?
   g. How do the programs train and compensate staff?

2. What does a cluster evaluation of existing science intervention programs reveal about their intent and efforts?

3. How can existing programs inform the development of models for science intervention programs for Black students?

Delimitations

The research focused on science intervention programs targeting elementary, middle, and/or high school minority students, and serving primarily Black students. Programs that incorporate math, technology, or other subjects in addition to science were included in the sample. The target population included science intervention programs administered by the 42 public universities in Washington, D.C., South Carolina, Georgia, and Maryland. These states are part of the South Atlantic sub-region, which contains the largest proportion of Black people in the South. The sample consisted of five programs in South Carolina, Georgia, and Maryland. These five programs comprised a cluster that was evaluated to determine the underlying meanings of science intervention in the South and to inform the development of two models. The exploratory nature of this study precluded any attempts to generalize the results to programs other than the ones represented. Because they suggest a sustained effort to effect change, continuous programs, not isolated efforts, were considered. Continuous programs included year-round intervention, school year efforts, and long-term (more than one week) summer programs. Examples of efforts that were excluded include those whose prominent activity consisted of competitions, fairs, guest speakers, or field trips and endured for a one-time or short-term (one week) basis. Inclusion in this study did not hinge on the funding for intervention being provided by the university. Federal, state, and private funding agencies offer grants to researchers and educators nationwide. Hence, the opportunity to establish intervention programs for minorities remains an option independent of the university's financial status. This gave the study external validity.

The American Association for the Advancement of Science (Rutherford & Ahlgren, 1990) described the impetus to make science for all before the year 2061. Efforts to replicate this study before 2061 should result in comparable findings. If, after the deadline, the focus of science education shifts, the attention of science intervention programs similarly will shift. Therefore, the reliability of the study remains intact as long as the goals of science education fail to undergo dramatic changes.

Limitations

The research was limited by the parameters of the investigation. Due to the types of programs studied, intervention efforts of other types may have been overlooked. Only programs that claim to target minorities were considered. Consequently, programs that claim to target other groups or no group in particular, but actually served minorities were not acknowledged. Due to the nature of this study, only programs administered by public universities were included. Intensive Internet searches facilitated the investigation. Intervention programs without web sites and those not acknowledged on a university web site were not identified, and were thus excluded. Variation in the program coordinators' participation affected the quality and quantity of information collected. While some coordinators shared information freely and made themselves available for additional queries, others provided minimal assistance. These limitations may have resulted in various levels of program description and a negative portrayal of current attempts to make science for all. The particulars of each intervention program varied with the needs, wants, and interests of the local communities they served. A lack of control of some of these program characteristics, as well as the personality of each program, threatened the internal validity of the research.

Significance of the Study

A cluster evaluation of existing programs presents new contributions to a dialogue among researchers, theorists, and practitioners. Two research-based models for science intervention programs for minorities and an evaluation of existing programs offer new knowledge to the relevant field of study.

Rather than assuming the effectiveness of science intervention programs for Black students, this study provides evidence that demonstrates the effectiveness of these programs. A cluster evaluation reveals strengths and weaknesses, as well as their underlying premises. As these ideas come under scrutiny, an argument emerges regarding the nature of the efforts to make science for all. The network of science intervention programs can be deemed as good faith efforts, bandage attempts, or some intermediate approach based on the analysis. The ensuing judgment contributes to the ongoing conversation about academic equity and equality and systemic reform among educational theorists, researchers, and practitioners.

Research indicates that most intervention programs are the result of educated intuition rather than research on how students learn and methods that work for minority students (Clewell, 1987). The proposed models arise from accepted research and empirical evidence. The development of models based on existing programs allows for the strengths of the programs to be matched and balanced.

Applications of cluster evaluation, a still-evolving approach, remain limited because of its current status. This study’s use of cluster evaluation will contribute to its use and to subsequent analyses of the approach. This study's significance to the field of science education is underscored by its contribution to the field of evaluation.

Assumptions

The research takes for granted the following assumptions:

- The intervention programs aim to increase student achievement in science and/or improve student attitudes toward science and science-related careers.
- The program participants (students and staff) are willing participants and without intentions to hinder the success of the program.
- The science for all initiative, highlighted by Project 2061, is a large developing project that subsumes existing science intervention programs.

Definition of Terms

The study utilizes the following terms as described below:

<u>Program administrator</u> – public university that implements the science intervention program, regardless of the funding source

<u>Program coordinator</u> – individual who manages and/or operates the science intervention program; usually affiliated with the university

<u>Science for all</u> – the goal of current efforts to transform American science education from an elitist system into an inclusive system that seeks to reverse the current underrepresentation of certain groups of students (i.e., females, African Americans and other racial/ethnic minorities, and students with disabilities) in science classes and science-related careers

<u>Science intervention program</u> – a continuous effort (i.e., in-school, after school, weekend, or summer) that targets elementary, middle, and/or high school minority students, serves primarily Black students, and attempts to increase any combination of science skills, knowledge, attitudes, or career awareness

Method

The study targeted science intervention programs administered by the 42 universities in Washington, D.C., Georgia, Maryland, and South Carolina. The sample included five programs in Georgia, Maryland, and South Carolina that were identified through extensive Internet searches, a review of the related literature, and communication with various personnel at the target universities. These personnel included faculty and staff in science, engineering, and education colleges/departments and offices of outreach, public service, continuing education, and minority recruitment. Preliminary information was collected through Internet and literature explorations until personal communication with the program coordinators was initiated. Some program coordinators provided additional information via a Program Coordinator Questionnaire. Site visits to two programs and interviews with program participants and staff supplied qualitative data, such as observations of program implementation and student and staff perceptions of the programs.

The collected data were used to describe the phenomenon of science intervention programs in the South. A modified cluster evaluation facilitated the examination and interpretation of the data. The strengths and weaknesses of the investigated programs and a review of related literature contributed to the development of two models for science intervention programs for Southern Blacks. Further details of the methodology of the study are provided in Chapter 3.

Summary of the Chapters

While this chapter contains a description of the problem and its significance to the field of science education, Chapter 2 provides a review of the relevant literature. Sub-headings within the literature review include gaps in science achievement and attitudes toward science, cultural contrasts in the classroom, the need for science intervention programs, research on science intervention programs, and postsecondary institutions and intervention programs. Chapter 3 details the research design and methodology. Chapters 4, 5, and 6 report the results of Research Questions 1, 2, and 3, respectively. A summary of the results, implications, and recommendations for future studies on science intervention programs are presented in Chapter 7.

CHAPTER 2
LITERATURE REVIEW

A study of science intervention programs for Black students would not be complete without an adequate review of pertinent literature. The following discussion highlights research in the areas of statistical data regarding women and minorities in science and engineering, gaps in science achievement and attitudes toward science, cultural contrasts in the classroom, the need for science intervention, research on science intervention programs, and postsecondary institutions and intervention programs. The "gaps in science achievement and attitudes toward science" section contains three sub-sections—gaps on achievement tests, differences in science experiences, and differences in science teaching. The "need for science intervention programs" section focuses on national industriousness and economic strength, group goals and democracy, and science and education. "Research on science intervention programs" considers the developmental level of students, inquiry learning, and attitudes and behaviors. In addition to sharing examples of science intervention programs, the section details various types of intervention programs, including private initiatives, school-college collaborations, federal and state-supported intervention, and academic outreach. The section concludes with an explanation of the K-16 Model.

Statistics on Women and Minorities in Science and Engineering

Participation of women and minorities in science can be correlated to their pre-college and college enrollment, as well as their involvement in the science workforce. The report *Women, Minorities, and Persons with Disabilities in Science and Engineering*

(National Science Foundation [NSF], 1998; NSF, 2000) presented relevant statistical data. Although women comprise 51% of the U.S. population and 46% of the workforce, they are only 22% of scientists and engineers (NSF, 1998). While Blacks, Hispanics, and Native Americans represent 23% of the U.S. population, they comprise approximately 6% of scientists and engineers (3% Blacks, 3% Hispanics, less than 1% Native Americans). Asians, though only 3% of the U.S. population, comprise 10% of the scientists and engineers in the U.S. (NSF, 1998). Between 1985 and 1995, minorities showed increases in the percentage of bachelor's degrees earned in science and engineering. Blacks represented 7% of all science and engineering bachelor's degrees awarded to U.S. citizens (up from 5%). Hispanics improved from 4% to 6%, while Native Americans earned 0.6% (up from 0.4%). During the same time period, women remained constant (near 38%) until the percentage of U.S. science and engineering bachelor's degrees awarded to women reached 46% (NSF, 1998; 2000). Examining the representation of women and minorities in science (and engineering) throughout the educational pipeline as well as in the workforce can provide insight on how gaps in participation can be alleviated.

Gaps in Science Achievement and Attitudes toward Science

In the United States, females and minorities traditionally have been underrepresented in the sciences, particularly the quantitative sciences. In April 1983, the National Commission on Excellence in Education released its groundbreaking report, *A Nation At Risk*, which described the inadequacies of the American educational system as a whole. Though this report did not focus on any one discipline, it spurred a number of reform efforts in many disciplines. Also in 1983, the Task Force on Education for Economic Growth issued a report, *Action for Excellence*, which focused America's attention on the issues of urban high schools and the minority students they serve. This report motivated urban school reform efforts. The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology released a report in 1983 that called for a number of programs to supplement formal education in mathematics, science, and technology. The mid- to late 1980s ushered in a wave of reform efforts and reports in science education. By 1988, a report by the Task Force on Minorities, Females and the Handicapped in Science acknowledged the presence of science intervention efforts but described them as being too sparse and underfunded to realize their full potential. Since these reports, and others, the problem of underparticipation of females and minorities continues to plague science education.

Gaps on Achievement Tests

Kahle and Lakes (1983) analyzed the results of the 1976-77 National Assessment of Educational Progress (NAEP). The NAEP, a standardized test administered to 75,000 to 100,000 students aged 9, 13, 17, and 26-35, tests knowledge in a number of academic disciplines. The researchers searched for data relevant to females and science, and excluded results from the 26-35 age category. Kahle and Lakes (1983) discovered what they termed the “myth of equality in science classrooms.” Essentially, girls have fewer experiences in science, which leads to a lack of understanding about the uses of science. This results in negative attitudes toward science and science understanding, and ultimately to a lack of participation in science as a career. Kahle and Lakes (1983) found that at age nine, girls have very positive attitudes toward science. As girls continue to age, their attitudes toward science become increasingly negative. The researchers purported that the girls’ lack of science experiences (or observations) directly affected their attitudes toward science.

Anderson (1989) also analyzed the results of the 1976-77 NAEP. She, however, focused on the data as they pertain to science and African American high school students (age 17). She noted an attitude-achievement paradox among Black students. Despite their positive attitudes toward science, they did not fare well on standardized science achievement tests. The results of current national and international science tests, such as the NAEP and the Third International Math and Science Study (TIMSS) and Third International Math and Science Study-Repeat (TIMSS-R), indicate that achievement gaps between Black and White and male and female students still exist (National Center for Education Statistics [NCES], n.d.a; NCES, n.d.b). On the 1996 NAEP, male and female students in grades 4 and 8 received similar scores; however in grade 12, males scored higher than females. White students earned higher average scores than Black and Hispanic students in all three grades (O'Sullivan, Reese, & Mazzeo, 1997). Middle and high school girls continually score lower on science achievement tests than their male counterparts though minimal science achievement gaps exist between elementary girls and boys.

Differences in Science Experiences

Catsambis (1995), Oakes (1985), Kahle and Lakes (1983), and Steinkamp and Maehr (1984) reported that male/female differences in science achievement do not emerge until the middle school years. However, once they emerge they remain fixed. Researchers attribute this to a lack of related science experiences from which girls can draw and then form connections to classroom science. Despite Steinkamp and Maehr's (1984) findings that girls are more positively oriented toward chemistry (a physical science) than boys, females typically fare worse in the physical sciences. Clewell, Anderson, and Thorpe (1992a) indicated that minority students perform at lower levels in science than White students as early as age nine. Scores on international tests, such as the TIMSS and TIMSS-R, and national exams, including the NAEP, offer confirmation (NCES, n.d.a; NCES, n.d.b; O'Sullivan et al., 1997). Additionally, the greatest difference in minority/White achievement occurs in the physical sciences. Minorities and females enroll in fewer advanced science courses, especially in physical sciences. Compared to males and Whites, females and minorities show less understanding of science content, inquiry, and science-technology-society issues (Anderson, 1989; Kahle & Lakes, 1983; O'Sullivan et al., 1997). These data illustrate the need for efforts to increase the performance of females and minorities in U.S. science classrooms.

Steinkamp and Maehr (1984) conducted a meta-analysis of the empirically based literature regarding gender and motivational orientations toward science. Coincidentally, much of the literature was published between 1981 and 1983, during the time of the science education reform rush (Weinburgh, 1995). Steinkamp and Maehr (1984) found that girls are more motivated in school-based science. They explained school-based science as those subjects (e.g., chemistry, biology, and botany) that students learn more readily at school. In other words, students are more likely to have educative experiences with chemistry in a formal setting such as school, than in an informal setting such as play. On the other hand, boys are more motivated in science subjects (e.g., physics) with which they are likely to have had experiences outside of school. Additionally, Steinkamp and Maehr (1984) reported that girls from disadvantaged communities have more positive attitudes toward, and higher achievement in, science than their male peers, and that boys from advantaged communities have more positive attitudes toward science than their female peers. The researchers concluded that because science is associated with school, and school success is deemed a feminine quality in disadvantaged communities, girls fare better than boys. For privileged youth, science bears a masculine image; therefore boys benefit, while girls maintain low interest, and in most cases, low achievement.

Oakes (1985) described the masculine image of science and the perception that girls find science boring, hard, and difficult to understand. This view of science can best be exemplified by the popular Draw-A-Scientist test (Chambers, 1983) in which students, when asked to draw a picture of a scientist, draw an old White male with a baldhead or messy hair, eyeglasses, and a lab coat. The lack of diversity in the illustrations reflects the homogenous image of scientists in the minds of American children.

Differences in Science Teaching

Contreras and Lee (1990) conducted an average of 30 classroom observations of two science teachers in different contexts. They observed one Black female and one White male middle school science teacher. Each teacher was responsible for one enriched class (primarily White students) and one mainstream class (mostly minorities). The researchers noted that the White male teacher clearly differentiated his pedagogy by race. To his enriched class he presented science as a useful, thoughtful endeavor to solve relevant problems. His students were involved in hands-on experiences and discussions. His attention was on the content and its applications. He afforded each student in the enriched class an opportunity to participate in a science field trip. To his mainstream class, on the other hand, the White male teacher presented science as seatwork and just another school subject. His students did not participate in hands-on experiences and he reserved the field trip for the most well-behaved students. His attention was on classroom management. The Black female instructor, however, presented a different perspective of teaching science. She nurtured her students both academically and personally, and provided to both classes hands-on experiences and full access to the field trip. She found that she made more efforts to motivate her mainstream students simply because they perceived themselves as ordinary, not highly capable students.

Just as classroom teachers differentiate their behavior based on race, they also differentiate based on gender. Tobin and Gallagher (1986), among other researchers, found that boys receive more teacher-attention than girls in science classrooms. Teachers are more likely to respond to boys' call-outs more frequently; call on boys more often; offer assistance to boys more than to girls; and more closely monitor boys. This lack of attention in the science classroom leads girls to substantiate Oakes' (1985) findings of the masculine image of science. Additionally, while doing group activities, boys are more likely to take the lead—handling the materials, manipulating equipment/instruments, observing, and talking about the science phenomena—while girls are often relegated to the tasks of taking notes, answering worksheet questions, and cleaning.

Cultural Contrasts in the Classroom

Historically, the specifics of educational reform have been devised with mainstream students (i.e., White, male, average to above-average performance) in mind, with the conjecture that they can be trickled down to non-mainstream contexts. Because these efforts fail to consider the perspectives of diverse learners, including alternative notions of knowledge and culture, they rarely succeed in providing an equitable education for all students (Rosebery & Warren, 1999). Instruction generates or maintains a cultural context that influences the extent to which a student learns. The basis of this influence lies in the congruity or incongruity between the culture of instruction and the student's culture (Aikenhead, 2001; Parsons, 2000). Norman, Ault, Bentz, and Meskimen (2001) describe urban science classrooms as cultural interface zones, in which teachers and students from diverse backgrounds and viewpoints must interact to achieve a common goal. The authors' perception of urban science classrooms, however, may be extrapolated to include any classroom that houses teachers and students from different circumstances.

According to Cobern, "In modern America, a primary goal of science education is the development of a scientific worldview, especially with regard to scientific ways of thinking" (as cited in Lynch, 2000, p. 73). Worldview, the underlying organization of the mind that directs one's thoughts and feelings, supports rationality and influences conceptions of norms and values. A typical student gains exposure to a variety of science worldviews as depicted in the school curriculum, science textbooks, science education reform efforts, peers, parents, and teachers. A student's conflict with the worldviews of science presented in school may predispose him to difficulty in science classes. On the other hand, a student may be favorably inclined to the notions of science presented in school (Lynch, 2000). The ability of a student to excel in science depends, considerably, on the negotiation between the habits of mind associated with the worldview of Western science and the habits of mind associated with the student's worldview.

Differences of perspective result in teachers deeming poor and minority students as "off-topic, confused, concrete rather than abstract in their thinking, magical rather than logical, lacking essential vocabulary, and not scientific in how they [approach] problems, how they [use] language, or in their understanding" (Rosebery & Warren, 1999, p. 8). These misunderstandings can be attributed to discrepancies between the cultural philosophies of White Americans and those of Black Americans, particularly several focal values as described by Parsons (2000).

As described by Parsons (2000), White Americans tend to subscribe to the notions of mind-body dualism, a materialistic conception of reality, individualism, and a work-related use of time. Black Americans embrace concepts of spirituality, harmony, affect, communalism, expressive individualism, and a social perspective of time. Mind-body dualism, the idea that the mind and body can be and should be separated, gives rise to a set of dichotomies including subject-object and affective-cognitive. This rationalist perspective views affect, or the expression of emotion, as disruptive to the process of making effective decisions. Mind-body dualism, a facet of White cultural philosophy, opposes the value placed on emotions and feelings by Black cultural philosophy (affect). The materialistic conception of reality accepted by White Americans suggests that all elements within the universe possess a natural, mechanistic order that accounts for an objective, static reality regardless of the perspective from which it is viewed. The Black cultural viewpoint, however, values spirituality and harmony (Parsons, 2000). These facets acknowledge how a supreme being, in addition to other elements of life, influences reality and fate.

While White cultural philosophy recognizes individualism as the basic human unit, Black Americans place a premium on communalism and expressive individualism (Parsons, 2000). Simply stated, individualism favors a person who is separate, independent, and distinct from others. Communalism prefers social interdependence and responsibilities rather than individual benefits. Expressive individualism acknowledges one's unique character and genuine personal expression. According to Parsons (2000), White Americans consider time a commodity, thus recognizing its value only when it can be translated into personal gain or use. Black Americans, on the other hand, view time as a "social phenomenon marked by human interaction and by the event shared by others" (Parsons, 2000, p. 212). Other facets of Black cultural philosophy include movement (intermingling ideas of rhythm and percussion), verve (preferring intense, lively stimulation), and orality (favoring oral/aural communication). These cultural contrasts, when present in science classrooms, yield differences in Black and White teacher and student interactions and expectations.

Manifestations of the previously discussed cultural differences between Black students and their White teachers and peers can account for gaps in behavioral interpretations and achievement. Morgan (1990) found that Black middle school students appeared more peer-oriented and socially interactive than their White counterparts. Consequently, Black students were more likely than White students to initiate peer-contact. These communalistic experiences may be misconstrued as disruptive to a teacher who does not provide social and interdependent instructional activities. Heath (1982) described the sociolinguistic characteristics of Southern Blacks. She found that Black working-class adults embraced a storytelling environment. Children who took initiative became welcome into the conversation, and earned approval through imaginative talk with dramatic expression. Additionally, working-class Black adults tended to ask their children "what is it like?" (analogy) questions. Middle-class White adults, though, expected more direct, specific responses from their children.

Traditionally, classrooms operate on teacher-controlled oral discourse. The teacher chooses the topic, and decides who talks and when. Students speak only with permission—one person at a time (Miller, 1995). A discrepancy exists between the socio-linguistic traditions of Blacks and the nature of traditional classroom discourse.

Students who have difficulty negotiating between the cultures of home and school struggle against teachers who do not even realize that such negotiations transpire. A science classroom under these conditions can provide the recipe for misfortune.

The Need for Science Intervention Programs

The need for intervention programs in science is a direct consequence of socioeconomic issues in U.S. education and failures in science classrooms. Concerns for the nation's industriousness and competitiveness, economic strength, realization of group goals, the maintenance of American democracy, and educational equity support the need for science intervention programs.

National Industriousness and Economic Strength

Miller (1995) and Johnson (1992) described similar motivations for science intervention programs. They discussed the implications of the 1950's launch of the Russian satellite Sputnik. After that major event, and in the wake of international math and science achievement tests, the United States' vulnerability became apparent. The nation realized its lack of academic competitiveness ultimately led to decreased scientific and technological capabilities, which placed it in grave danger of not being a leader among the "industrialized nations club" (Miller, 1995, p. 6). Finding sources of untapped science potential meant encouraging the participation of underrepresented groups, hence the birth of science intervention programs.

Miller (1995) further described the need for two major groups of people in any industrialized nation—the educated elite and the well-educated general population. The educated elite consists of those individuals who possess the expertise and knowledge to create, modify, or discover scientific and technological advancements. The educated elite, also known as the advancers, remains a relatively small proportion of the population. The general population, on the other hand, comprises the vast majority of the nation's people. The well-educated general population, or appliers, serves to apply the advancements of the elite to daily life. The challenge lies in balancing the knowledge of the elite with that of the general population. Contributions of the advancers that far exceed the knowledge base of the appliers lead to inefficiency, ineffectiveness, and lack of success on the part of the nation. The need exists for science intervention programs to heighten the education of the general population and increase the pool of the educated elite.

Group Goals and Democracy

Johnson (1992) and Miller (1995) both offered benefits for increased participation of females and minorities in science. These groups remain most underrepresented in areas of study that most affect them. Examples include health care, biomedical research, and environmental issues. Encouraging minorities and females to enter science-related careers provides a variety of new perspectives to research questions. Issues of well-being that had previously been addressed from a White male perspective gain attention from minorities and females. This affects the overall welfare of those groups. Additionally, as females and minorities become more visible in historically underrepresented fields, they may feel a greater sense of responsibility to maintain and increase their visibility. As their contributions increase and their participation becomes noticeable, more females and minorities may consider careers in science. This group self-edification also allows each group to realize the fullness of its recently won civil rights.

Johnson (1992) argued that science intervention programs increase female and minority participation in the sciences. Gains in knowledge and representation eventually lead to gains in power, and ultimately to entry into the decision-making process. Females and minorities who continue to struggle to take advantage of their civil rights find easier access as their science knowledge/power increases.

John Dewey's (1944) image of the Great Society—one that fosters participatory democracy—can be realized through the effects of science intervention programs, according to Miller (1995) and Johnson (1992). Dewey (1944) envisioned a society in which every individual participates in the social, political, and cultural life, and strives to maintain the ideals of democracy. Inequities in the current situation prevent the full participation of each individual. Disparities in the science achievement and experiences of minorities and females when compared to the cultural majority and to males remain an obstacle to the Great Society. Miller (1995) and Johnson (1992) recognized science intervention programs as efforts to attain equity and parity.

Science and Education

Atwater (2000) distinguished equality and equity. She defined equality as "the state of being the same," and equity as "the state of being fair or just" (Atwater, 2000, p. 155). The U.S. educational system fails to provide equitable opportunities for minorities and females to achieve success in science. Equal opportunities do not address the inability of minorities and females to begin at the same level. Atwater (2000) highlighted unfair funding/resources, unprepared teachers, and apathetic teachers as sources of inequity. Schools in disadvantaged neighborhoods tend to serve minority students more than schools in wealthier neighborhoods. Interestingly, poorer schools receive less funding for science supplies; tend to have more inexperienced or improperly trained teachers; and subscribe to Haberman's (1991) pedagogy of poverty—one that views the core functions of urban teaching as giving information, asking questions, giving directions, making assignments, monitoring seatwork, reviewing assignments, giving tests, reviewing tests, assigning homework, reviewing homework, settling disputes, punishing noncompliance, making papers, and giving grades. This type of pedagogy is "sufficiently powerful enough to undermine the implementation of any reform effort because it determines the way pupils spend their time, the nature of the behaviors they practice, and the bases of their self-concepts as learners. Essentially it is a pedagogy in which learners can 'succeed' without becoming either involved or thoughtful" (Haberman, 1991, p. 292). As teachers gain experience, they tend to prefer suburban schools (with fewer minority students than urban schools). This relegates inexperienced teachers to the schools that need the most skilled instructors. The attitudes and behaviors of students who have been conditioned to the pedagogy of poverty by previous teachers disenchants excited, new instructors who quickly revert from their constructivist pedagogy to one more familiar to their students.

Because most standardized tests previously focused only on math and reading skills, science instruction rarely occurred throughout the elementary school years. As states begin to mandate science assessments, and as President Bush's *No Child Left Behind Act* (U.S. Department of Education, 2002), which will eventually include science, comes to fruition, the need for science interventions will increase.

Research on Science Intervention Programs

Clewell, Anderson, and Thorpe's (1992b) comprehensive study of 163 science, mathematics, and computer science intervention programs that targeted minorities and females in grades four through eight revealed an interesting fact—the developers of most intervention programs do not consider major philosophies or theories when creating their programs. Instead, they rely on what Clewell (1987, p. 99) termed "educated intuition," empirical data on what works in similar programs, and years of trial-and-error in search of the right fit. This process creates a wide array of intervention program models that bear common characteristics. Clewell (1987) described intervention as those programs that aim to achieve a goal or goals the school has been unable to reach. Universal traits of academic intervention programs include (Clewell, 1987):

- Operating separately from the school system (although they may include in-school components).
- Targeting a particular group or groups of students.
- Focusing on a specific educational issue rather than the entire realm of problems specific to the target group(s).
- Considering the needs and interests of the target audience.
- Maintaining student-centeredness, rather than teacher-centeredness.
- Offering a range of activities and experiences that aim to address various aspects of the targeted educational issue.
- Arranging the activities so that all participants experience some level of success.

Through their investigation of numerous science intervention programs, Clewell et al (1992a) identified underlying educational and developmental theories. Despite the lack of acknowledgement of these theories by the program developers, the researchers note three complementary relationships—developmental level of the students, benefits of inquiry learning, and the relationship between attitudes and behaviors.

Developmental Level of the Students

Science intervention programs span the educational pipeline. While the first intervention programs primarily focused on high school and undergraduate students, today's programs include elementary and middle school as well (Clewell, 1987). Each segment of the educational pipeline demands certain needs. Consequently, program coordinators must consider the developmental needs of the students they wish to serve.

The cognitive theory proposed by Inhelder and Piaget (as cited in Clewell, 1987) describes the mode of thinking most prevalent in schoolchildren—concrete. By presenting science concepts as concrete, through examples, hands-on experiences, and observations, then gradually moving towards the abstract, intervention program participants can gain an understanding of concepts. Additional researchers, including Bandura and Dorman (as cited in Clewell, 1987) acknowledged adolescents' need for social interaction, role models, and cooperative learning situations.

Inquiry Learning

Taba and Suchman (in Clewell, 1987) presented models of inductive thinking and inquiry learning that benefit student learning. Both types of models "are concerned with the ways people handle stimuli from the environment, organize data, identify problems, generate concepts and solutions to problems, and employ verbal and nonverbal symbols" (as cited in Clewell, 1987, p. 11). The inquiry approach serves as an effective approach to intervention in that it requires disciplined independence. Examples of models of inquiry include rational (involves student/teacher discussions), free discovery (student has limitless access to the materials with which to manipulate), guided discovery (teacher uses questioning to direct the materials' manipulation to a certain end), and experimental (student follows specific steps in problem solving) (Clewell, 1987). Most intervention programs encourage active participation in the learning process through hands-on, inquiry experiences (Clewell, 1987).

Attitudes and Behaviors

Bem's Theory of Self-Perception underlies many science intervention programs (as cited in Clewell, 1987). According to Bem, a student with positive personal experiences with a phenomenon (in this case, science) will gradually begin to view that phenomenon through a rose-colored lens. In other words, as students participate in science, their attitudes toward science grow more positive. Intervention programs offer varied experiences—such as hands-on activities, field trips, and guest speakers—that aim to nurture positive student attitudes, and eventually lead to increased participation in science. Mentors and role models provide additional positive reinforcement for the above-named science experiences.

Program developers seem to heed Berryman's (1983) suggestion that science intervention programs that target females focus on fostering more positive attitudes toward science first, then deal with achievement and that intervention programs for minorities focus on achievement while nurturing the students' already positive attitudes toward science.

Examples of Intervention Programs

Programs such as Project SPLASH! (Murphy & Sullivan, 1997) that target minority females in grades 7-9 incorporate cooperative learning and non-competitive situations. Project SPLASH! involves a cooperative venture between Washington University and Heritage College (located on a Native American reservation). Participants spend three weeks at one of the campuses experiencing hands-on science activities related to water and wave activity. During the fourth week, students from both campuses work together on educative, theme-related activities. The minority female participants, most of who are African American and Hispanic, work in social situations and avoid the competitiveness and stereotypes perpetuated by their male peers. Interestingly, few opinions have been offered regarding the focus of programs designed with minority females in mind. Should attitudes toward science or science achievement be addressed first? Project SPLASH! appears to consider both by offering science stimulation in a comfortable environment. The use of hands-on activities related to common yet commonly unstudied phenomena (i.e., water and wave activity) supports student-centered inquiry learning.

Project Interface (Clewell, 1989), an Oakland, California science intervention program, fosters tutoring/mentoring relationships between local community college and high school students. Based at Allen Temple Baptist Church, Project Interface incorporates heavy parental participation as well. Each community college student works with small groups of high school students to increase their achievement in school science. Additional activities include social functions, field trips, and guest speakers. Though Project Interface does not utilize an inquiry model, it aims to increase achievement via academic tutoring. The personal relationships developed serve as positive reinforcement, in accordance with Bem's theory (as cited in Clewell, 1987). The location of Project Interface serves as a key factor in the effectiveness of the program. Housing Project Interface within the students' community demystifies science as an endeavor only for the elite. This, to a certain degree, removes science from the metaphorical pedestal that has long kept minorities and females from full participation. Although Project Interface does not provide any hands-on science activities, its presence in the local community, rather than at a nearby college or university, remains a huge step.

Broward County, Florida's Saturday/Summer Science Academy targets high-potential urban high school students who are not currently enrolled in college-preparatory courses (Crawley, 1998). The program offers a comforting situation for students who may feel out of place while at school because of their motivation for academic success. The five-week summer component incorporates hands-on science experiences to increase students' proficiency and knowledge of experimenting skills, science content, and science-related careers. The Saturday component provides additional support and relevant activities during the school year. Students who participate in the Academy throughout their four years of high school earn dual enrollment credits at the local community college, as well as Advanced Placement credits. The Academy, therefore, hones in on students' concerns for their future while extending a supportive social network.

Despite the varied formats of science intervention programs, key characteristics that are common to intervention can be identified. Though the particular needs of minorities and females have been recognized in current research, little discussion of intervention strategies for minority females has been offered. Nonetheless, through educated intuition, reliance on empirical evidence, and trial-and-error, science intervention programs have made great strides.

Postsecondary Institutions and Intervention Programs

In a 1966 study of nearly 600,000 students, James S. Coleman reported two major findings related to the educational attainment of minority students:

> (1) these minority children have a serious educational deficiency at the start of school, which is obviously not a result of school; and (2) they have an even more serious deficiency at the end of school, which is obviously in part a result of school. Altogether, the sources of inequality of educational opportunity appear to lie first in the home itself and then cultural influences immediately surrounding the home; then they lie in the schools' ineffectiveness to free achievement from the impact of the home, and in the schools' homogeneity, which perpetuates the social influences of the home and its environs. (pp. 72-74)

This report is said to have shaped the Great Society legislation of the mid-1960s, including the Civil Rights Act of 1964, the Elementary and Secondary Education Act of 1965, and the Higher Education Act of 1965, in that it aimed to improve the condition of education for minority students both in school and out of school. The legislation attempted to balance the resources of schools and the opportunity to access these resources, as well as to improve the academic achievement of minority students through a variety of support services and programs.

A historical dichotomy exists between elementary and secondary institutions and postsecondary institutions. Since the mid-19th century, primary and secondary education have been compulsory and viewed as fundamental to the civic and economic survival of the United States. Postsecondary schooling, on the other hand, has been considered elective, selective, and elitist (Fenske, Geranios, Keller, & Moore, 1997).

Types of Intervention Programs

The past 20 years have ushered in a “vast, uncoordinated proliferation of programs” designed to ease the elementary/secondary-postsecondary gap for disadvantaged and underrepresented students (Fenske et al., 1997, p. 1). These intervention programs offer financial assistance and encouragement to needy youth, their families, and their communities. With funds from federal, state, local, and benevolent sources, intervention programs attempt to develop seamless transitions from elementary to secondary to postsecondary education. Four categories (private initiatives, school-college collaboration, federal and state-supported intervention, and academic outreach) span the six types of intervention programs currently in existence. These six types include: (a) programs established by charitable organizations, (b) federally supported programs, (c) state-sponsored programs with matching federal support, (d) entirely state-supported programs, (e) systemic changes involving school-college collaborations, and (f) college or university-sponsored programs (Fenske et al., 1997).

Private initiatives. Private foundations, including the Ford Foundation, Carnegie Corporation, and DeWitt Wallace-Readers' Digest Fund, continue to support intervention programs (Fenske et al., 1997). Grants awarded to public and private colleges, school districts, and educational organizations and associations fund projects that include mentoring, counseling, financial assistance, and academic training for students. Recently, the number of privately funded initiatives has decreased perhaps due to adverse changes in tax laws and an increase in federally funded intervention programs (Fenske et al., 1997).

School-college collaborations. School-college collaborations began as a major component of the educational reform movement of the 1980s. These collaborations range from short-term, K-16 programs with specific aims to systemic changes that involve seamless transitions through the educational pipeline. Partnerships between postsecondary and elementary/secondary institutions "recognize demographics of the student population and the need to target efforts toward minority and at-risk students traditionally underserved by either institution" (cited in Fenske et al., 1997, p. 36). Systemic changes include broad issues such as teacher and administrator preparation and the allocation of funds and resources.

Federal and state-supported intervention. The involvement of the federal government in intervention programs most notably includes the TRIO programs (Upward Bound, Student Support Service, Talent Search, and the Ronald E. McNair Post-baccalaureate Achievement Program). With the exception of the McNair program, which targets minority students, these programs serve students from low-income households. Each involves some combination of summer enrichment programs, Saturday activities, college/career counseling, and financial assistance. TRIO programs operate under the auspices of the Department of Education on over 1,200 college and university campuses (Fenske et al., 1997). State-supported intervention programs generally aim to increase high school graduation rates, increase enrollment of at-risk students in math and science courses, prepare high school graduates for careers and/or college, and encourage in-state college attendance (Fenske et al., 1997). Georgia's HOPE program serves as an example of a state-supported intervention.

Academic outreach. Academic outreach programs, usually administered by colleges or universities, represent an expansive mix of intervention programs. Academic outreach can pursue nearly any goal and be initiated by any institutional unit including a college, department, center, program, or individual. Funding for outreach programs can be obtained from a variety of sources. Some academic outreach programs focus on recruiting and preparing students to pursue a specific discipline, such as science or math, and others offer a broader view of college preparation and readiness.

The K-16 Model

School-college collaborations, a burgeoning theme since the early 1980s, demand systemic change as schools and universities work together to address issues of educational accountability. The disappointing results of the *A Nation At Risk* report (National Commission on Excellence in Education, 1983) catalyzed the K-16 model as a means to improve the academic achievement of American students when compared on an international level. College and university-sponsored intervention programs benefit both the students they serve and the host institutions. While the students gain enhanced educational opportunities, the institutions create a system to recruit and prepare potential matriculants. Colleges and universities that examine the intervention efforts that directly affect their institution can then develop programs to close service gaps and avoid unnecessary duplication. An interesting paradox exists between the institutions' need to serve their local areas and the competition between an institution's academic departments. The drive for each department to recruit a diverse sample of students from a limited local population lessens cross-campus coordination of intervention efforts (Fenske et al., 1997). Consequently, the self-interest of any one academic unit far outweighs the collective interests of all the units (i.e., the college or university). Additionally, finding a single source of information about all the academic intervention programs offered by one university proves to be a difficult task.

CHAPTER 3
METHODOLOGY & METHOD

The study was designed to investigate the underlying meanings of existing science intervention programs for elementary through high school Southern Black students. Using data from print materials, site visits, questionnaires, and interviews, the study identified implicit patterns that represent the nature of efforts to achieve the goal of Project 2061—science for all. Additionally, the study utilized the strengths and weaknesses of existing science intervention programs to develop two models for new and/or modified programs.

The study was organized into three phases—description and interpretation, evaluation, and model formation. The study design is further explained in a section of this chapter entitled “study design.” The study identified 46 potential science intervention programs administered by the 42 public universities in South Carolina, Georgia, Maryland, and the District of Columbia. Of those 46 programs, 15 targeted and recruited minorities, and met the other criteria to be included in the sample. Five of the 15 eligible programs participated in the study.

Research Questions

The research answered the following questions:

1. What intervention programs do Southern state universities offer in an effort to make science for all?
    a. What are the objectives of the programs?
    b. What are the formats of the programs?
    c. Where do the programs occur?
    d. What populations do the programs target?

   e. How are participants recruited and selected?
   f. What types of intervention do the programs provide?
   g. How do the programs train and compensate staff?

2. What does a cluster evaluation of existing intervention programs reveal about their intent and efforts?

3. How can existing programs inform the development of models for science intervention programs for Black students?

The research was conducted using a modified approach to cluster evaluation. The core qualities of science intervention programs for minorities were ascertained and analyzed for their meanings and associations. This led to the development of a stance regarding the overall implications of existing science intervention programs.

Methodology

The study applied cluster evaluation to science intervention programs in a unique way. A cluster can be defined as several individual, local programs that share a common mission, strategy, or population, and that usually fall under a broad intervention initiative (Worthen & Matsumoto, 1994). This cluster of programs can be appraised collectively to assess the broad initiative, rather than each program. This discussion undergirds the justification for using cluster evaluation to critically analyze science intervention programs for Southern Black students. This discussion emphasizes: the historical development of cluster evaluation, a description of the approach, its relationship to other forms of evaluation, and the current status of cluster evaluation.

Historical Development of Cluster Evaluation

Despite the lack of solid documentation of the origin of cluster evaluation, scholarly lore suggests it was first used in 1988 by the W.K. Kellogg Foundation (WKKF) to appraise a group of individual, local projects that shared a common mission, strategy, or population (Barley & Jenness, 1993; Straw & Herrell, 2002; Worthen &

Matsumoto, 1994). In accordance with the values of the foundation, cluster evaluation sought "to improve, not prove" (cited in Worthen & Matsumoto, 1994, p. 7). WKKF was not interested in identifying the causal effects of their funded programs, but rather adopted cluster evaluation "to answer fundamental questions about policy and programming, including the central question of whether the strategy which led to funding the cluster of projects was a wise investment of Foundation resources" (Worthen & Matsumoto, 1994, p. 7). In addition to its use as an appraisal tool, cluster evaluation has been used as a tool for program development (Burnham, 1999). Patton (as cited in Burnham, 1999) termed the use of cluster evaluation during the early stages of program development as "active-reactive adaptive [evaluation]" (Burnham, 1999, p. 10). Since its inception, cluster evaluation has been tailored to satisfy various sizes of clusters, geographical locations of projects, compositions of target populations, and degrees of similarity of program implementation. These differences have confounded an effort to define and prescribe methods for conducting cluster evaluation.

Description of Cluster Evaluation

According to WKKF, the fundamental purpose of cluster evaluation is "to answer the questions, "what happened and why?" for the cluster of projects as a whole" (as cited in Worthen & Matsumoto, 1994, p. 5). A key function of cluster evaluations is to "examine initiatives or interventions based in local communities to identify common themes or components that [were] associated with positive impacts, as well as the reasons for these associations" (Straw & Herrell, 2002, p. 7). Worthen and Matsumoto (1994) furthered Straw and Herrell's explanation by outlining four key traits of cluster evaluation: (a) identifying the common threads and themes of related programs that bear great significance when viewed as an aggregate; (b) explaining what happened with respect to the cluster, as well as why those events occurred; (c) encouraging collaboration between the programs, funding source, and evaluator, and (d) reporting the data as a collective, rather than emphasizing individual programs. Burnham (1999) discussed the four characteristics used to define cluster evaluations: (a) the involvement of multiple sites; (b) a focus on long-term projects; (c) the application of different approaches, within the cluster, to similar problems, and (d) a goal to improve, on a large-scale, the social condition. Cluster evaluations report only comprehensive data, and do not disclose information about specific programs included in the cluster. This allows the evaluator to determine the overall impact of the cluster without evaluating the effectiveness of individual programs. Cluster evaluations typically take place during program development, or in the early stages of a program, and are thus classified as formative evaluations. Through collaboration, cluster evaluations can provide credible information about programs from the perspectives of various stakeholders, including funding sources, program staff, and the public (Barley & Jenness, 1993).

Cluster Evaluation and Other Forms of Evaluation

The cluster evaluation approach is often associated with multisite evaluations. Sinacore and Turpin (1991) were among the first researchers to use the term multisite evaluation (MSE). Although the authors recognized a lack of established criteria for defining a MSE, they did emphasize two factors that distinguish MSEs from other forms of evaluation—the use of multiple sites and an evaluation based on cross-site analysis. Among MSEs, these factors can contain variations regarding the number of sites included in a study, the operational definition of a site, and specific characteristics of a site, such as geographical location and program implementation. Multisite evaluations can be classified as retrospective or prospective, based on the data collection process utilized.

Retrospective MSEs rely on data already collected by each site, whereas prospective MSEs rely on data collected by the evaluator. Sinacore and Turpin (1991) identified two subtypes of multisite evaluations: (a) a program that is implemented in the same way at different geographical locations and (b) a program that is implemented in different ways at different geographical locations. MSEs, concerned with standardization, seek generalizable and replicable findings.

Straw and Herrell (2002) described three types of multisite evaluations, one of which is cluster evaluation. Worthen and Matsumoto (1994), however, find only superficial similarities between cluster evaluation and multisite evaluations. They suggest the two approaches are “actually rather distant conceptual relatives, not the close conceptual cousins they may appear to be upon casual inspection” (Worthen & Matsumoto, 1994, p. 10).

Worthen and Matsumoto (1994) discussed how cluster evaluation fits in with more widely held concepts and ideas in evaluation. They identified 11 key concepts including: evaluation, informal versus formal, formative versus summative, internal versus external, evaluation as a scientific activity, evaluation as a political activity, alternative evaluation approaches, meta-evaluation, generalizability and replication, standardization and control versus treatment variability, and cross-site communication. Each of these is discussed below.

- Evaluation purists may consider cluster evaluation to be policy analysis or a form of social intervention that supports and facilitates evaluation. While cluster evaluation should be considered a form of evaluation, cluster evaluators often find themselves serving roles beyond evaluation. Evaluators who subscribe to other forms of evaluation face this situation as well.

- Despite its still-emerging status, cluster evaluation involves systematic efforts to identify and apply criteria and strategies. Thus, cluster evaluation is a form of formal evaluation.

- Cluster evaluation can be formative and summative with respect to the larger initiative being investigated and formative with respect to the individual programs.

- Typically, cluster evaluators are external evaluators, though individual program evaluators may be internal.

- The use of empirical and philosophical inquiry grants cluster evaluation its status as a scientific activity. The evolving nature of cluster evaluation deems this scientific activity as less disciplined than other forms of evaluation.

- The concept and practice of cluster evaluation can be described as a political activity or a rational activity occurring within a political context.

- The classification of evaluation approaches based on their orientations (e.g., objectives, management, consumer, expertise, adversary, and participant) poses a problem for cluster evaluation, which does not fit neatly into any widely used categorical scheme.

- Meta-evaluation of programs is avoided by cluster evaluation. Cluster evaluators do not seek to critique the evaluations of individual programs. Meta-evaluation does not bode well for the cross-site aggregation of data.

- Generalizability and replicability are of little concern in cluster evaluation.

- Cluster evaluation does not require standardization of program implementation, and views implementation as a product of the personality of each program site.

- Sharing information across sites is at the core of cluster evaluation. This is considered one of the strengths of the evaluation approach.

Status of Cluster Evaluation

Internal documents for WKKF and annual contributions from American Evaluation Association presenters have yielded several manuscripts and publications about cluster evaluation (Worthen & Matsumoto, 1994). Relative to other evaluation approaches, however, little research has been conducted on cluster evaluation. Though cluster evaluation has been applied most frequently within WKKF, the method continues to evolve and distinguish itself as a worthwhile contribution to the field of evaluation.

"Perhaps it is being in the throes of adolescence's awkwardness that raises so many issues [about cluster evaluation] that need to be resolved. But if these issues are resolved, there is great potential for cluster evaluation to make a broader contribution, for many state and federal agencies fund programs with multiple projects that could use such a strategy, if cluster evaluation can be captured conceptually in ways that allow its use to be clearly understood by potential users in various contexts where a non-causal [multisite evaluation] were deemed appropriate]" (Worthen & Matsumoto, 1994, p. 22). Hence, additional research and examples of appropriate use are necessary for the continued development of cluster evaluation. Furthering the use of cluster evaluation could result in a standardized language and set of core concepts. This will better position it as an established approach to evaluation.

The cluster evaluation approach benefits science education in that it allows a broad perspective of pertinent issues. In the case of science intervention programs, cluster evaluation moves beyond the limits of investigating a single program, and into the realm of identifying and describing shared themes, patterns, strengths, and weaknesses. Though single-program studies remain valuable sources of information, they do little to portray the relationship among related programs or between programs and the overall initiative. This study's significance to the field of science education is underscored by its contribution to the field of evaluation.

Unique Application of Cluster Evaluation

The study assumed the science for all initiative, highlighted by the coming of year 2061, to be a large developing program. This larger program, though subsuming smaller science intervention efforts, remains in its formative stages. While the individual programs discussed in this study have surpassed the need for formative evaluation, the larger initiative has not. Thus, the current cluster evaluation of programs compliant with science for all represents a formative evaluation of the initiative. Using a modified approach, this study applied cluster evaluation to the analysis of science intervention programs for Black students. The modifications satisfied the aforementioned major characteristics described by Burnham (1999) and Worthen and Matsumoto (1994).

Burnham's (1999) characteristics of cluster evaluation included: (a) the involvement of multiple sites; (b) a focus on long-term projects; (c) the use of different approaches, within the cluster, to similar or the same problems, and (d) a goal to improve, on a large-scale, the social condition. The current study emphasized science intervention programs for Black students across South Carolina, Georgia, Maryland, and the District of Columbia. Public universities administered each program. Five programs formed the cluster, and thus represented multiple sites. None of the cluster programs was a short-term effort. Each had been in operation for the past several years, and the duration of each program was yearlong and/or summer intensive. Hence, the cluster represented long-term programs. The cluster aimed to address the problem of underparticipation of minorities, particularly Blacks, in the sciences. Using various formats and activities, each program attended to the issue. Because the underparticipation of any group of people in a field of study precludes that group's perspective, encouraging full participation yields positive results for that group and others. The cluster used science intervention to promote science involvement among Black students, thus affecting the disciplines of science, the Black population, and potentially, society, as a whole.

Worthen and Matsumoto (1994) identified the following characteristics of cluster evaluation: (a) identifying the common threads and themes of related programs that bear great significance when viewed as an aggregate; (b) explaining what happened with respect to the cluster, as well as why those events occurred; (c) encouraging collaboration between the programs, funding source, and evaluator, and (d) reporting the data as a collective, rather than emphasizing individual programs. The current study investigated the cluster of science intervention programs for common patterns and themes. Further analysis of these commonalities revealed the underlying intents and premises of science intervention programs targeting Black students. When viewed as a whole, this delineated an interpretation of the meaning of science intervention for Black students. For the purpose of explicating how data collection and analysis occurred, information about individual programs was included. These descriptions identified each program by a pseudonym. The essence of the study, however, called attention to the cluster, rather than individual programs. The models for science intervention developed by the researcher represented key elements of each of the cluster programs, as well as related literature. The models denoted a modified collaboration among the cluster. Although program coordinators and funding sources did not physically participate in the model-building process, their ideas and insights regarding their particular programs comprised significant contributions. The model took into account the context and characteristics of each program. As described above, the overall analysis of science intervention in the South was reported as an aggregate.

Study Design

The study design was organized into three phases—description and interpretation, evaluation, and model formation. Description and interpretation consisted of collecting data about each science intervention program and analyzing the data for patterns. This phase answered Research Question #1. Evaluation involved making a judgment about the meanings and intents of the cluster of science intervention programs. Research Question #2 was answered by the evaluation phase. This process informed the development of two models for science intervention for Black students, which was a response to Research Question #3. See Appendix A for a visual representation of the study design.

Research Question #1

The first research question (what intervention programs do Southern state universities offer in an effort to make science for all?) was answered by a thorough examination of artifacts related to the specific intervention programs included in the sample. The sample consisted of five science intervention programs administered by four public universities in South Carolina, Georgia and Maryland (see Appendix B). Continuous programs, rather than isolated efforts, were considered. Continuous programs include year-round intervention, school year efforts, long-term (more than one week), and summer programs. Examples of efforts that were excluded are those whose prominent activity consists of competitions, fairs, guest speakers, and field trips on a one-time or short-term (one week) basis. Examination of relics such as web pages, brochures, articles, reports, and other print sources was guided by the aforementioned sub-questions (see the Research Questions section of this chapter). In the event of unavailable or outdated print sources, personal contact with program coordinators was attempted via mail, electronic mail, or telephone. The information sought by personal contact was also guided by the sub-questions. Additionally, a questionnaire (see Appendix C) was mailed to a program coordinator representing each intervention program. The questionnaire supplemented the artifact data.

Identifying the Sample

The extensive Internet search began with thorough investigations of each university's web site. Key pages accessed (where available) for each university included departments and/or colleges of science, engineering, education, and offices of outreach, public service, continuing education, and minority recruitment. Electronic messages were sent to central personnel for each unit. These messages served to clarify information presented on the web sites and to direct the researcher to other sources, if necessary. Additionally, Internet and site-specific keyword searches were initiated using combinations of the following words: African American, after school, Black, children, education, elementary, enhancement, enrichment, high school, intervention, middle, minority, outreach, pre-college, program, public, Saturday, science, summer, and youth.

Initially, twenty-one programs were identified, but further examination of the available information and communication with key personnel revealed missing criteria, such as lack of a target group, non-minority target group, short-term duration (one week or less), and emphasis on teachers not students. Consequently, six programs were removed from the sample. As these program coordinators were contacted, they contributed information that deemed them unsuitable for the study. One program served teachers rather students. Two program representatives identified their programs as defunct. One program offered only a one-week intervention, while another program's funding was so recent that an actual intervention had not been established. One program did not target a specific group of students, while another program targeted students not relevant to this study. Two program coordinators provided minimal assistance via telephone and electronic communication, but did not return the signed consent form that made them eligible to complete the Program Coordinator Questionnaire (see Appendix

C) or to host a site visit. Eight program coordinators chose not to participate in the study. In those cases, the funding sources were contacted to provide proposals and annual reports that contained much-needed data including program objectives, target group, types of intervention activities, and staff information. Only one funding source responded with the appropriate information and within the deadline. A private agency with no obligation to provide information freely, offered a report that contained no specific information regarding the intervention program of interest. A third agency, despite its federal responsibility to make information available to the public, did not respond to numerous requests. After reviewing all data related to each of the identified programs, and eliminating programs that did not meet the conditions specified by the study, fifteen science intervention programs remained. Of the fifteen programs, five were represented by coordinators who were willing research participants, and one coordinator represented two programs.

Collecting Data

Clewell, Anderson, and Thorpe (1992a) identified five key components of science intervention programs—goals, design, content, context, and outcomes. Goals refer to program objectives, while design focuses on format, location, and recruitment/selection. Content emphasizes program staff and activities. Program design and content interact to produce the desired participant-related outcomes. These outcomes can include students' attitudes, performance and achievement, course-taking, and career choice. The context considers the elements that exist outside of the program, yet still affect the program, such as funding opportunities, the need for the program, and collaborative relationships with the local community and institutions. The interrelationship and interdependence of these elements determine the effectiveness of each program (outcomes). Additionally, investigating each component of a science intervention program provides a comprehensive view of the processes that affect the program's success or failure. This study concentrated on the components of program goals, design, content, and context. Context was modified to include student fees and stipends as factors that should not be overlooked when examining science intervention programs. Due to the variation in intervention programs and the focus of this study on descriptive patterns and evaluative meanings, program outcomes and the specific characteristics of each local area were not investigated. Despite the significance of these two components, both represent aspects of science intervention programs that were not crucial to this study. These aspects delve into the particulars of specific programs, and therefore pose conceptual challenges when conducting a cluster evaluation that focuses on broader features of programs. While these aspects should be investigated in future studies, they were beyond the scope of this study.

A Data Analysis Tool (see Appendix D) allowed for cross-comparison of the various intervention programs in relevant categories associated with proposed standards for science intervention programs. The categories included program objectives, program format, program location, target population, recruitment and selection, intervention activities, staff information (demographics, training, compensation, qualifications), and financial information (funding source, stipends, fees). The standards are discussed later in this chapter. Data on the following categories were collected via Program Coordinator Questionnaires (see Appendix C) and supplemented by personal communication with program coordinators and print materials such as web pages and brochures.

Program objectives. Program objectives, comparable to program goals, arise out of a need to address a specific problem. A program's objectives also determine its format and scope (Clewell et al., 1992a). Consequently, a program that aims to increase awareness of science-related careers will differ from a program that strives to improve classroom achievement in science. An examination of the objectives of existing science intervention programs reveals their goals and an expectation of the types of activities that should be offered. The articulation of a program's objectives to participants and staff affects their ability to achieve those goals. Furthermore, the program objectives and corresponding activities illustrate the perceived strengths and weaknesses of the target group.

Some objectives of the programs involved in the study include: to increase student performance on national and state performance tests, to help students learn math and science concepts, to create a familiar environment for learning science and math, to excite students about science and math, and to introduce students to space science and stimulate their awareness of relevant careers.

Program format. "[Intervention] programs use a wide range of formats, and some combine two or more formats" (Clewell et al., 1992a, p. 96). Program format refers to when a program operates (after school, during school, on Saturdays, and/or during the summer), its duration (several weeks, yearlong, or by semester), and the length of each meeting (all day, half-day, or set number of contact hours). An examination of format reveals a connection between program objectives. The needs of a program shape its format. For example, a program that intends to encourage positive attitudes toward science may meet more regularly or in more concentrated periods of time than a program designed to introduce science-related careers. The format can also account for the quantity and quality of the science experiences to which students are exposed. Programs that meet frequently or for long periods of time are better suited for in-depth discussions, intense hands-on activities, real-world connections, and field trips or guest speakers. Programs that meet infrequently or for short periods of time simply lack the time for deep studies.

The study sample included the following program formats: one day per week for 20 weeks during the school year and a two week summer component, six-week summer program, two-week summer academy, and 10 consecutive Saturdays during the spring semester.

Program location. Intervention programs vary in location. Some occur at local elementary, middle or high schools, while others utilize university facilities, community centers, or churches. Local schools offer convenience and familiarity to program participants, but likely lack the resources to conduct science experiments, visit laboratories, and meet scientists and college students. University facilities meet these needs, though often without the convenience of a neighborhood school. Additionally, university campuses provide the amenities of a residential program—room, board, and a variety of teaching spaces. Despite their benefits, intervention programs that occur at local schools or universities can perpetuate the idea that science is a remote endeavor; that one must go elsewhere to see or do science. The use of community centers or churches combats this idea by bringing science from its hypothetical pedestal to the neighborhood. This offers an accessible perception of science, particularly to disadvantaged neighborhoods. The science intervention programs included in the study occurred at a local church, a community center, middle schools, and universities.

Recruitment/selection and target population. Intervention programs recruit and select students who meet their target criteria. A program that recruits in a specific neighborhood or school is likely to attract a different type of student than a program with a broader recruiting range. Likewise, a program that recruits in a suburban, middle class neighborhood will attract students who are dissimilar to urban, lower socioeconomic students. While some programs recruit specific types of students, others invite a wider assortment of participants. Some programs select their participants by grade point average, intelligence quotient, at-risk status, teacher recommendations, or penchant for science, though others select on a first-come, first-served basis. The recruitment and selection processes of existing science intervention programs distinguish their target populations. Programs that claim to target any minority student will recruit and select differently than a program that prefers high-performing minority students.

The recruitment activities of the programs evaluated in this study involved partnerships with schools and community organizations, announcements at local churches, and word-of-mouth. The target populations identified in the study included minority students who were in a specific or range of grade levels, residents of a particular state or county, inner-city dwellers, and considered at-risk.

Intervention activities. “The effectiveness of approaches and strategies depends on a knowledge of the target population and on the application of theoretically sound practices” (Clewell et al., 1992a, p. 98). Activities that include role modeling, mentoring, exposure to real world and hands-on science experiences, and career discussions stimulate positive attitudes toward science and science-related careers. Experiences that focus on tutoring, science enrichment activities (both remediation and intensive studies), unique instructional strategies, and test preparation encourage students to improve their academic performance and science achievement.

The study identified programs that employed the following activities: worksheets, hands-on science activities, field trips, guest speakers, design projects, reading, cross-disciplinary experiences (math, technology, art, critical thinking, public speaking, and writing), model-building, career exposure, and special instruction.

Program staff. Information about staff members, including number, demographics, qualifications, training, and compensation, provides insight regarding the ability to effectively meet the programs' objectives. The demographics of the staff, when compared to that of the participants, may shed some light on the effectiveness of the intervention program. For some students, undergraduate staff members can be more effective role models or mentors than older staff because of similar or shared experiences as a result of fewer generational differences. Ethnic and gender diversity among staff can play a role in their perceptions of the participants and their ease in relating to them. While the qualifications and training of staff members impact their ability to achieve the objectives of the programs, their compensation may affect their commitment to the success of the program. Volunteers may be less consistent and less dedicated than staff who receive financial compensation or course credit. A course, program, or departmental requirement may encourage undergraduate participation, but at the cost of high turnover. Students' fulfillment of a requirement may preclude them from continuing their participation with the program. Although a new student replaces the old, the uniformity of the program can be compromised.

The programs included in the study comprised undergraduate science and engineering majors, undergraduate students from a variety of majors, pre-service, in-service, and retired teachers, and university professors. Many staff members were volunteers, but most were paid for their participation.

Financial information. While recruitment and selection criteria explicitly engage or disengage certain types of students, the financial cost of participation serves to implicitly include or exclude others. Programs with exorbitant fees can discourage low-income families while free programs appear more inviting. Though fee-based programs usually provide some scholarships or other financial assistance, this information is not widely publicized. Thus, not only must help be requested, but parents must know that the help is available. Stipends can motivate participation and allow students to earn money as they improve their science awareness, interest, and/or performance. The source of funding determines the extent to which fees and stipends are available. Internal funding (university) may be more prohibitive than external funding (state, federal, or a private granting agency). Hence, university-sponsored programs may require a fee payment.

The research identified programs that required a weekly fee, no fee, a registration fee, and offered no stipends. The funding sources included state governments and federal agencies.

A critical analysis of the interrelationship among the eight aforementioned facets of science intervention programs disclosed vital information regarding the underlying premises of these programs. Data collection was followed by examination, and was used to develop models for science intervention programs for Black students.

Examining Data

As the artifact, questionnaire, observation, and interview data were examined for characteristics in the aforementioned categories, the distinguishing qualities of each science intervention program emerged. These qualities were recorded in a data analysis tool (see Appendix D) that allowed for a cross-comparison of the intervention programs.

Research Question #2

The second research question (What does a cluster evaluation of existing intervention programs reveal about their intent and efforts?) was answered using methods described by Taylor and Bogdan (1984). Hence, the collected data were examined repeatedly to discover themes and patterns. As themes and patterns surfaced among the categories for one program and across all programs, they were classified and further examined until the simplest classifications remained. Various interpretations and ideas about science intervention programs emerged and were recorded. A scheme was developed to classify program characteristics and identify themes. This scheme was directly related to the data: "It is through concepts and propositions that the researcher moves from description to interpretation and theory" (Taylor & Bogdan, 1984, p. 133), thus classification yielded concepts (abstract ideas generalized from empirical facts) and propositions (general statements of facts grounded in the data), and ultimately, a storyline. This storyline was analyzed, using as a backdrop a description of standards (see below) to be upheld by science intervention programs for Black students, and resulted in numerous interpretations, themes, concepts, and propositions of such programs. The standards, developed by the researcher, were based on educated intuition and related research. The changing results of the analysis were identified and described. The data were further examined to identify additional categorization, and a clear distinction of the type of data that fit each category was made. The categories were examined for overlap, leading to the emergence of major coding categories. The coding system was continually inspected for commonalities and reduced to the fewest number of unique categories. All the data were then coded and categories modified as needed in accordance with the "[cardinal rule of coding in qualitative analysis]—make the codes fit the data and not vice versa" (Taylor & Bogdan, 1984, p. 137). The data were physically sorted into coding categories. Only the data that fit the analytical scheme were used. As new categories surfaced, the interpretations were refined. A new analysis re-examined the data in the context in which they were collected. This process of discounting (Taylor & Bogdan, 1984) provided credibility to the data by considering:

- Solicited versus unsolicited data
- The presence of the researcher on the setting during site visits
- Personal bias and assumptions
- Sources of information.

The result was a critical portrayal of science interventions in the South, as represented by the five programs included in the study.

To facilitate the cluster evaluation and because none currently exist, a set of standards for science intervention for Black students was developed by the researcher. The standards described below specify criteria that should be considered when planning science intervention programs. These standards, based on the researcher's educated intuition, personal experience, and a review of the related literature, delineate qualities of effective programs. These qualities relate to the core categories associated with intervention programs (Clewell et al., 1992a): objectives, format, types of activities, target population, selection/recruitment, program location, staff information, and financial information. While each of the other categories comprises its own section, relevant financial data is included in the participants and staff sections.

The following standards were based on the researcher's experience and knowledge of past and present science intervention programs, as well as related literature on science intervention and science education, including the National Science Education Standards (National Research Council [NRC], 1996). The standards represent the researcher's perception of qualities that should be addressed in science intervention programs for Black students.

Program Objectives

The objectives should focus on science process skills, science content knowledge, attitudes toward science, and science-related careers (SKAC). Science intervention should incorporate these four components to provide students opportunities to learn and apply science process skills and content. Increasing their proficiency may positively affect their attitudes toward science, and themselves as doers of science. This, in turn, may encourage Black students to pursue science-related careers. Furthermore, students' attitudes toward science can affect their interest in science, and ultimately the pursuit of a science-related career.

Though Black students report positive attitudes toward science during their elementary years, their achievement levels remain low (Anderson, 1989; Catsambis, 1995). Science intervention programs should allow Black students to do science by focusing on skills enhancement and career awareness (Berryman, 1983; Clewell, 1987). This will help maintain the positive attitudes of elementary students and encourage positive attitudes among middle and high school students. SKAC addresses two barriers to minority participation in science—low performance levels in science courses and on standardized tests and insufficient interest or knowledge of science-related careers (Clewell, 1992a).

Objectives should represent a range of cognitive (knowledge, understanding, inquiry, processes), affective (attitudes, values, habits of mind), psychomotor (physical skills), and social (communication, interaction) learning outcomes (Carin & Bass, 2001). This well-rounded approach can strengthen students' perceptions of science and increase their content knowledge and skills, while showing how this improvement can benefit them in the future. Focusing on SKAC may give students the much-needed relevance to make science an important entity in their lives, while answering the following questions: What are the skills of science? How can these skills be used in all aspects of my life? What science knowledge is important to know at my developmental level? How can my science literacy be used to make informed decisions everyday of my life? How do I feel about science? How do I feel about myself as a doer of science? What are my perceptions of science? And how can my science skills, knowledge, and attitudes be used to benefit society in the form of a career? As a minimum standard, the program objectives should aim to increase any combination of at least two of the following: skills, knowledge, attitudes and/or career awareness. Ideally, all should be emphasized.

The objectives should be clearly articulated to staff members via training, regular meetings, handbooks, or some other notable presentation. The articulation of the objectives to the staff can increase the likelihood of those objectives being met. The more the staff learns about the goals and purposes of the program, the better they can tailor their activities to achieve those ends. The standard suggests that the objectives should be clearly articulated to staff members during pre-program training. Ideally, these objectives should be reiterated during the course of the program at regular meetings (especially for yearlong programs).

The program objectives should be clearly articulated to participants and their parents via informational sessions, handbooks, informative letters, or some other notable presentation. Parents and participants should be well aware of the objectives, purposes, and goals of the program prior to the program's commencement. A parent who is concerned about his/her children's science grades needs to know if the program will meet their needs. Of integral importance is finding the right fit between program and participants. At a minimum, the objectives should be clearly articulated to participants (and parents) via a pre-program informational session, letter, or handbook. Ideally, the parents should be invited to a recruiting session where the objectives will be discussed in detail.

The program's objectives should be measurable, and should be measured. An internal or external evaluator should measure the objectives to determine the extent of success to make suggestions for improvement and to identify gaps in service delivery. At a minimum, the objectives should be measured via traditional methods (e.g., paper-pencil tests, surveys, and gains in test scores and grades) by an internal evaluator. Ideally, the objectives should also be measured via alternative methods (e.g., interviews, observations, portfolios, and performance tasks) by an external evaluator.

Program Format

Each program's format should be consistent with its objectives. The program format should represent the goals and purposes of the program (Clewell et al., 1992a). To provide the most effective science intervention programs, the format should offer the best possible platform for the goals and purposes. As the standard, program developers will use their objectives to determine the best format for their programs.

A science intervention program should offer frequent contact during the program duration to facilitate sustained inquiry and understanding during extended investigations (NRC, 1996). For as long as the program operates, students should be in contact on a regular basis. Daily and weekly sessions constitute a regular basis. The effectiveness of a program can diminish as the length of time between each session increases. At a minimum, for concentrated sessions (i.e., summer components), meetings should be on a daily basis, and for widespread sessions (i.e., year-round) meetings should be on a weekly basis. This is also the ideal.

Sessions should occur during concentrated periods of time throughout the program's duration. Programs should offer a summer component of at least two weeks to reinforce the yearlong component. This concentrated period of time can provide intense study, increased interaction with peers, mentors, and role models, and a period of science emphasis with fewer outside distractions than a weekly component can provide. The researcher's personal experience with science intervention and other youth programs has shown that two weeks is a sustained period of time that is long enough to positively impact students and maintain consistent attendance. In two weeks, students can pursue an interest, engage in a variety of relevant activities, and develop friendships. Additionally, participants and parents are more likely to insist on daily attendance because of the seemingly short duration of the program. Regular absences during a two-week program can decrease the quality of the intervention experience for participants. Competing activities, such as summer school, vacations, family events, camps, and other programs, can affect a student's participation in a science intervention program. A lengthy program has a greater likelihood of overlapping other activities and interests. This can result in sporadic student attendance and decreased family commitment, and can reduce the positive impact of the program. As the standard, programs should offer a summer component of at least two weeks. Ideally, the program should be residential in nature and/or at least three weeks.

Students should be given the opportunity to continue their participation for additional years or sessions. Continuity can be important in the life of a child (Santrock, 1998), thus continuous involvement in a meaningful program can serve to motivate, inspire, and positively affect each participant. Furthermore, continuous involvement may improve the effect of the intervention activities, whether they are geared toward skills, knowledge, attitudes, or careers. At a minimum, programs should give students the opportunity to continue their participation for one additional year. Ideally, students should continue their participation throughout the duration of their schooling (as long as they stay in the local area).

Program Location

Programs should operate at community sites other than schools or university campuses. Programs that occur in community sites can help remove science from its hypothetical pedestal (Rahm & Downey, 2002). The act of demystifying science can encourage students to view science as accessible rather than as a remote endeavor. Participants can realize that they need not travel elsewhere to see or do science. Community-based science intervention programs can also provide an additional use for community spaces. For example, a local center that normally houses athletic games, community forums, and talent shows can be utilized as a site for science programming.

This may broaden the realm of usage for that site, while giving the community access to and ownership of science education. At a minimum, programs should occur primarily at a community site or neighborhood school, not on a university campus. The university and school campuses should supplement the community-based intervention by allowing access to well-equipped laboratories and other facilities. Ideally, programs should occur in a community site and directly relate to the community.

Programs not operated in the community should take field trips or conduct projects/activities within the community. Examples include visiting a local lake to test its water quality or using local industry as a resource for highlighting careers in science (NRC, 1996). The science intervention should not be limited to the university, school, or other host site. Students should be encouraged to see and do science in their own communities (Rahm & Downey, 2002). As the standard, programs not operated in the community should use community sites for projects/activities and field trips. This should occur at least twice during the program. Ideally, all science intervention programs should use community sites for a majority of their projects/activities and field trips.

Programs should be operated in sites that foster hands-on science activities (NRC, 1996). These sites should be equipped with plenty of tabletops, work space, sinks, floors that can handle spills, comfortable seating, comfortable temperature, and adjustable lighting. These characteristics can promote an active learning environment that invites hands-on activities. Additionally, the site should provide access to science equipment and the supplies necessary for science experiments, activities, and demonstrations. As a standard, programs should have ready access to an environment that fosters hands-on activities and provides access to science equipment and supplies. Ideally, programs should have a fully equipped laboratory for science intervention.

Participants

Program participants should represent a range of achievement levels. A heterogeneous group of students can be important for peer collaboration, peer tutoring, and exposing students to others with whom they may not normally interact due to differences in course taking. Programs should not be limited to high-performing, low-performing, or even average students. A diverse group of students can motivate some, provide opportunities to help for others, and prevent the further stigmatization of students who spend much of their school day in academic tracks. As a standard, programs should recruit a wide variety of student achievement levels. Ideally, a special effort should be made to ensure that many levels of student performance are represented.

Unless specifically designed to provide opportunities for males or females, programs should strive for equal representation of both sexes. The racial/ethnic composition of the program should reflect the target population, but not to the omission of other races/ethnicities. Programs designed to attract Black students, for example, should not exclude other minorities or White students on the basis of race/ethnicity.

To encourage relationship building, a small participant-to-instructor ratio should be maintained (Achilles, Finn, & Pate, 1997/1998). This situation should afford staff members the opportunity to work with students on a one-on-one or small group basis. The level of comfort between the staff and students can increase, and the interactions can become positive. The researcher's experience in youth programs with participant-to-instructor ratios as high as 15:1 indicates that a smaller proportion should be established. The wide range of student achievement levels coupled with the need to manage materials and student engagement provide challenges that may be alleviated by a smaller ratio. Most school field trips require a 10:1 participant to chaperone ratio. Science intervention programs should go further, as they are designed to "[utilize] approaches somewhat different from those of the traditional educational system" (Clewell et al., 1992a, p. 13). As a standard, programs should seek to sustain a participant-to-instructor ratio of 8:1. Ideally, the ratio should be 6:1.

To avoid the implicit exclusion of students, every effort should be made to offer a free or very low cost program. The program's major activities should be affordable, with special experiences offered at additional fees, given the availability of funds. Fees should be appropriated only if necessary. If fees become inevitable, financial assistance or scholarships should be readily available. These options should be publicized and offered to several students. Ideally, the program should be free for all students.

Students should feel wanted by the program through active recruitment. Programs should excite students and motivate them to sign up, rather than convince parents to send their children. The goal should be for students to want to attend, not to feel like they must. The researcher's experience with science intervention program participants who enrolled due to parental requirement rather than personal interest provides a rationale for this standard. While these students complain and disengage from the program, they create mischief and disruption. Regardless of how these students feel about specific science activities, their attitudes toward themselves as doers of science may never improve, thus inhibiting their pursuit of science-related careers. This undermines the purpose of the science intervention program. Additionally, active recruitment can also bring new participants to the program, rather than relying on former students to return.

These students can rejuvenate the program while impacting their peers. The standard suggests that programs should recruit students, not just parents. Ideally, programs should recruit families.

Unless specifically targeting a particular underserved neighborhood, community, or school, programs should make an effort to serve a wide variety of students. The mixing of neighborhoods, communities, and schools can introduce students to other youth, help ease local rivalries, and broaden the experiences/exposure of the participants. Different neighborhoods, communities, and schools bring different viewpoints, experiences, and realities. Allowing students an opportunity to interact with different kinds of people can develop open-minded and aware citizens.

Intervention Activities

Each program's activities should be consistent with its objectives. The program format and activities should represent the goals and purposes of the program (Clewell et al., 1992a). To provide the most effective science intervention programs, the format and activities should offer the best possible platform for the goals and purposes. As the standard, programs should use base their format and activities on the objectives they have determined.

Programs should offer a variety of activities to satisfy the needs of various learners (NRC, 1996). The activities should span disciplines, learning styles, and grouping arrangements. Activity examples include hands-on experiments, design projects, math-enriched lessons, language-enriched experiences, art-enriched activities, creative/critical thinking, traditional activities (worksheets, quizzes), oral projects, individual, pair, and group work, short-term projects, and long-term projects. The activities should feature real-world issues and dilemmas. At a minimum, programs should offer hands-on activities, traditional activities, group work, and individual work. Ideally, a wider variety of activity types should be offered in comparable proportions.

Science intervention programs should provide opportunities for hands-on activities. Hands-on experiments and design activities should be a fundamental part of the program (NRC, 1996). Science intervention programs should encourage active involvement of participants. Students should be actively involved in the program activities, and not viewed as mere receptacles. An abundance of lectures, videos, and worksheets does not constitute active involvement. As a standard, programs should offer at least three hands-on activities per week (for summer components) or one per session (for year-round) and at least one design project for summer and year-round components.

Programs should allow expose participants to mentors and role models. Mentors and role models can motivate and inspire students to achieve their goals (Ferreiera, 2002). Female and minority mentors in science can demonstrate to these underrepresented groups the potential for success in science (Stern, 1997). Exposure to mentors and role models should consist of college students (undergraduate and graduate) and professionals who represent the fields of interests, genders, ethnicities, and backgrounds of the student participants, as well as other diverse groups. At a minimum, programs should offer mentors in the form of staff members who represent a range of genders, ethnicities, and cultural backgrounds, including those of the participants. These mentors should be older than, but in the same generation, as the students. These mentors should be in regular contact with the students (i.e., present at every session). Programs should offer role models in the form of guest speakers, staff, or biographical studies representing a range of genders, ethnicities, and cultural backgrounds, including those of the participants. These role models should be presented at least twice for summer programs and at least once every three meetings during yearlong programs. Ideally, the role models should be present at every session.

Programs should introduce students to science-related careers. Programs should emphasize, through role models and career presentations, the variety of science-related careers available to students. Programs should make an effort to determine student interests and relate those to possible careers in science. The purpose of increasing student achievement and student interest to decrease the levels of underrepresentation in science would be for naught if students fail to eventually choose careers in science. As a standard, programs should emphasize a variety of science-related careers, including examples of professionals, descriptions of the type of work involved, and discussions of preparing for such careers. This should be accomplished via field trips, guest speakers, biographical studies, and discussions. Ideally, these careers should represent commonly considered (e.g., research scientist, science teacher, engineer, and science faculty) and less common careers (e.g., science illustrator, science writer, sales representative, science reporter, and public relations).

Program Staff

Programs should make every effort to staff a diverse group (regarding gender, race, and ethnicity) of intervention personnel. Diverse demographics can increase the likelihood of shared or similar experiences, backgrounds, and viewpoints (Aikenhead, 2001; Norman et al., 2001; Parsons, 2000) thus providing a positive means for role model/mentor relationships to form.

Staff should be given the opportunity to continue their participation for additional years or sessions. Continuity can be important in the life of a child (Santrock, 1998) thus continuous involvement in a meaningful program serves to motivate, inspire, and positively affect each participant. Furthermore, continuous involvement may improve the effect of the intervention activities, whether they are geared towards skills, knowledge, attitudes, or careers. As relationships are built between staff and students, the benefits of the intervention can increase. At a minimum, programs should give staff the opportunity to continue their participation for one additional year. Ideally, staff should continue their participation throughout the duration of a group of students' participation.

Programs should require intensive staff training that emphasizes the goals, purposes, and objectives of the program prior to its start. Staff should be aware of, and agree to support, the policies, activities, and ideals of the program. Programs should also provide a written version of this information for staff to refer to as necessary. Based on the researcher's personal experience with various educational programs for youth, intensive training is essential. Without explicit, interactive, and thorough training, program staff run the risk of misinterpreting the objectives of the program. As this misinterpretation results in implementation, the vision of the program developers may be lost. Moreover, simply reading a handbook or attending a brief meeting does not sufficiently prepare staff for the science intervention program. The standard suggests that programs should require a four-hour workshop or seminar as a pre-program training session. Ideally, pre-program training should occur for one to three days

Programs should offer financial or academic compensation to staff. While the qualifications and training of staff members can impact their ability to achieve the objectives of the programs, their compensation may affect their commitment to the success of the program. The researcher's experience with volunteers has shown that they can be less consistent and less dedicated than paid staff (whether the payment be financial compensation or course credit). As their schedules become less permissive or their interest wanes, volunteers can become less committed. A course, program, or departmental requirement may encourage undergraduate participation, but at the cost of high turnover. Based on the researcher's personal experience, as students fulfill their requirement, they may not continue working with the program. Although a new student replaces the old, the uniformity of the program can be compromised. As a standard, staff members should be offered financial or academic compensation. While some volunteer staff is appropriate, most should be compensated.

Research Question #3

Empirical and critical evidence from existing science intervention programs and theoretical evidence from related literature provided the foundation for two models of science intervention programs for Black students. The strengths of the sample programs were emphasized and correlated to the standards to inform the development of the models. These models were intended to influence existing and/or new programs.

CHAPTER 4
RESULTS FOR RESEARCH QUESTION #1

The study identified 46 science intervention programs administered by the 42 public universities in South Carolina, Georgia, Maryland, and the District of Columbia. Of those 46 programs, 15 targeted and recruited minorities and met the other criteria to be included in the study. Five of the 15 eligible programs participated in the study. This chapter answers Research Question #1: What science intervention programs do Southern state universities offer in an effort to make science for all? Other questions addressed in Research Question #1 include: what are the objectives of the programs, what are the formats of the programs, where do the programs occur, what populations do the programs target, how are participants recruited and selected, what types of intervention do the programs provide, and how do the programs train, compensate, and pay staff? For the purpose of detailed reporting, the program names and university affiliations have been altered, however Appendix E lists all of the identified science intervention programs.

The discussion of each science intervention program includes the 2000 Carnegie Classification of the associated university. The 2000 Carnegie Classification includes all U.S. colleges and universities that grant degrees and bear accreditation by an agency recognized by the U.S. Secretary of Education (Carnegie Foundation for the Advancement of Teaching, n.d.). The Carnegie Foundation used data from 1995-1996 through 1997-1998 to generate the 2000 Carnegie Classification. The programs included in this study represented three classifications: (a) Doctoral Intensive, (b) Master's I, and (c) Master's II. According to the Carnegie Foundation for the Advancement of

Teaching's web site, Doctoral Intensive institutions "typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the doctorate. During the period studied, they awarded at least ten doctoral degrees per year across three or more disciplines, or at least 20 doctoral degrees per year overall." Master's I institutions "typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the master's degree. During the period studied, they awarded 40 or more master's degrees per year across three or more disciplines." Likewise, Master's II institutions, "typically offer a wide range of baccalaureate programs, and they are committed to graduate education through the master's degree. During the period studied, they awarded 20 or more master's degrees per year."

Program 1—MidCom

Administered by a Master's I, state-funded university in Northwest Georgia, the MidCom Program offered middle school students an opportunity to prepare for post-secondary education while emphasizing science and math. Supported by state initiatives, the overall goal of the program was to help students in grades 7-12 meet tougher college admissions standards as established by the Board of Regents for the state university system. In its second year of operation, MidCom represented one university's efforts to achieve this goal, while using science and math as the vehicle of choice. The fictitious name highlights two important qualities of the intervention program—a middle school (Mid) target audience and its use of community sites (Com) to house the program. Observations and interviews during a visit to the summer component, the Program Coordinator Questionnaire, and artifact data provided the following information about the MidCom program.

Program Objectives

The program coordinator identified the following objectives of MidCom: (a) to prepare at-risk students to better prepare for post-secondary admissions, (b) to create (during the summer) a familiar environment for learning science and math, (c) to help students learn science and math concepts, and (d) to improve the attitude of students concerning career options in science, mathematics, and engineering.

The program coordinator articulated the objectives to MidCom staff via workshops, brochures, and individual conversations. Parents and participants learned of the program objectives through presentations at their respective school or community site, as well as through the paperwork each parent received. The first two program objectives appear difficult to measure, though all were measured by: the number of students who participated in the program, the number of students who completed the program, student attitudes during and after the program, and ultimately the number of students who succeed in college. This information was collected by the program coordinator and staff.

Program Format

MidCom operated during the school year, as well as in the summer. The school year component met one day per week for 20 weeks from August through May. The 20-week component was divided into two 10-week sessions, and each session served a different group of 25 students. In other words, no student was allowed to participate in more than one school-year component. These meetings were held after school. Five days per week for two weeks comprised the summer component. These meetings, in June, lasted from 9:00 a.m. until 3:00 p.m.

Program Location

As aforementioned, MidCom was administered by a Master's I level university in Northwest Georgia. Four sites were utilized during the summer—two middle schools, a church, and a girl-oriented community center. At each middle school, one classroom with computers and a laboratory area were available. The church used a large multi-purpose room with nine large tables and plenty of floor space. MidCom participants at the girls' center congregated in a compact room with five large tables and a conference room with one large table. Despite differences in the facilities, each site served approximately 25 participants. While close to 70% of the program's activities provided little interaction among the four sites, students from all sites attended field trips and participated in the culminating activity together. During the after-school component, only the two middle schools housed the program.

Target Population

MidCom targeted students in grades 6-8 who were considered at-risk due to barriers caused by financial status, lack of knowledge, poor academic skills, race, religion, national origin, or gender. One stipulation of the statewide initiative was that the program be comprised of at least 60% students from underrepresented groups (i.e., African American, Hispanic Americans, and Native Americans). Due to the location of the administering university and the partner schools and organizations, MidCom was designed to attract at least 80% minority students primarily from one county.

Recruitment and Selection

MidCom recruited participants through its partnerships with local middle schools and youth-focused civic organizations. Announcements and flyers at these target locations, in addition to flyers distributed at community churches provided recruitment opportunities. To be considered, students were required to complete an application and student information sheet, write an essay describing their interest in the MidCom summer program, and obtain parental consent. Students who participated in the summer component were expected to continue their participation during the following school year. Furthermore, through a series of collaborations with other programs, the participants will receive intervention from 6th grade through their college years.

The participants were chosen by a team of representatives from MidCom and the partner schools and organizations. The team considered the applicants' desire and commitment to attend college, as evidenced by their essay and information sheet. Other criteria used to select participants included the number of students to be served (100 maximum); the desire for diversity in terms of race, ethnicity, social status, financial status, and academic skills; students' willingness and ability to complete the program; and students' willingness to accept a leadership role among their peers. Approximately 85% of the participants were African American, while 10% were Hispanic Americans. The remaining 5% consisted of Caucasians, Asians, Native Americans, and other racial/ethnic groups. Nearly 65% of the students were female, with 35% being male. No more than 1-2% of the students reported a mental or physical disability. Most participants were classified as below-average students, and some were considered honor students.

Intervention Activities

MidCom's summer component utilized a variety of activities, including reading, maintaining a journal, worksheets, hands-on laboratory activities, field trips, guest speakers, and special projects. The beginning of the summer session began with team-building activities such as name games, a human scavenger hunt, learning and reciting the student pledge, and taking group photographs. Additionally, students divided into teams that were used throughout the summer for group projects and competitions. Each team created a name, designed a banner, wrote a song, composed a slogan, and developed a cheer. The student pledge and individual team cheers became an integral part of each day's activities. Several students per day were assigned various leadership roles, such as photographer, time manager, and journal manager. These incentives allowed students to take photographs of the MidCom group, manage the time allotted for each activity, and collect the journals.

The teams competed in various contests, such as assembling a tower of uncooked spaghetti, constructing a rocket-powered car, building a bridge, and solving math problems. Other group activities included creating Power Point® presentations to promote the MidCom program throughout the community, using the local newspaper to learn science, identifying the components of a mystery brew, and designing a science experiment. The instructors devoted time to highlighting observation as a science process skill, describing selected scientific discoveries and inventions, allowing students to practice mathematical operations via worksheets, and using brainteasers to motivate students to think critically and creatively.

The middle school students were introduced to various types of colleges and universities—2-year, 4-year, technical, private, and public. A college scavenger hunt and presentations by their instructors facilitated this process. During the 2-week summer component, five field trips to neighboring colleges, universities, and a nature center allowed the students to meet college students, professors, and researchers. After each field trip, the students were expected to record the experience in their own journal. In fact, the students were expected to record each day's experiences in their journal. Each field trip lasted approximately five hours, including travel and lunch. Tours of the various facilities and special presentations of current research were included in all field trips. A laser show was one presentation the students particularly enjoyed. The emphasis on colleges and science-related fields of study was supplemented by discussions on scholarships, federal grants, and federal loans. As students were instructed on the specifics of a state funded scholarship program (i.e., Hope program) they learned how to begin to make themselves eligible for those funds. The culminating experience for the students was an overnight stay on a college campus. MidCom participants enjoyed a barbecue with their families and invited guests, displayed their projects and awards from the summer program, and ended the evening with a dance before retiring to their dormitory rooms. The next morning, after eating breakfast in a campus cafeteria, the summer component officially ended.

The after-school component consisted of sessions that highlighted the goals of the program and student expectations, requirements and costs of college, presentations by the program coordinator, hands-on science activities, various guest speakers, worksheet-based math problems, real-world based math problems, educational Internet activities, web page design, and an awards reception.

Staff Information

MidCom employed approximately 20 staff members, including two instructors per site, a team of coordinators, and other help. Most of the staff members were retired, in-service, or pre-service teachers who received specialized training (twice a year) for the MidCom program. The program coordinator was a full professor in the biology department at the administering university. Additionally, a training manual for future staff was in the development stages. The staff members were invited to participate in future years/sessions, and had already received the initial training for the upcoming after-school component. Compensation varied from $200 to $12,000 and was based on the quality and quantity of time devoted to the program. All staff were paid. The ethnicity of the staff was comparable to that of the participants, with 75% African American, 20% Caucasian, and 5% Hispanic American, African, and other racial/ethnic groups. Only one of the eight staff members was male.

Financial Information

MidCom operated free of charge to participants and offered no stipend. The program's funding ($90,000 per year) came from both a statewide initiative and a regional initiative within the state.

Program 2–Elchurch

Administered by a Master's I, state-funded university in Northwest Georgia, the Elchurch Program offered elementary students an opportunity to become excited about science and math. The fictitious name highlights two important qualities of the intervention program—an elementary (El) target audience and its use of a neighborhood church (church) to house the program. The Program Coordinator Questionnaire and artifact data provided the following information about the Elchurch program. Though for five years, the program had provided much-needed science experiences for younger children, the program coordinator's growing emphasis on middle and high school intervention ultimately phased out the Elchurch program. After the summer session ended, a comprehensive elementary program was no longer offered. Hence, the following data relates to the final session of Elchurch.

Program Objectives

The program coordinator identified the following objectives of Elchurch: (a) to excite students about science and math to the degree that they want to participate in them and (b) to have students learn new practical knowledge and skills that will help them throughout their educational careers.

Program staff learned the objectives via teacher workshops, staff meetings, and in all of the written material they received. Parents and participants were informed of Elchurch's objectives at the orientation, from written materials, and via constant reminders from the staff. Staff, student, and parent surveys, administered by the program coordinator, served as an assessment tool. The participants' attitudes toward science were measured by attendance and behavior patterns of the participants, while science skills and knowledge were assessed via worksheets and hands-on activities.

Program Format

Elchurch operated during the summer, and participants met five days per week for six weeks. These sessions were from 9:00 a.m. until 5:00 p.m., and in July and August.

Program Location

Elchurch operated at a Baptist church located in the heart of the African American and public housing communities in the program's service area. The congregation of the church was mostly African American. The program activities occurred primarily in the multi-purpose room and classroom areas in the church. These rooms were equipped with large tables, many chairs, and sufficient floor space to avoid cramped quarters.

Target Population

Elchurch targeted students in grades 2-5 from the local area. The program sought to engage the area's minority populations, African Americans and Hispanic Americans. Students representing a wide range of abilities were encouraged to participate.

Recruitment and Selection

Elchurch recruited participants through announcements and flyers at local churches, in addition to word of mouth. Despite the desire of the program coordinator to attract participants from the area's relatively large Hispanic American population, Elchurch attracted only African American students. Participants were accepted on a first come, first served basis until capacity was reached. Also, because a weekly fee was charged to all participants, no applicant was rejected on any basis other than program capacity. Scholarships were available for students who were unable to pay.

Intervention Activities

Elchurch utilized a variety of activities, including reading, solving puzzles, playing games, telling stories, watching videos, creating art, conducting science experiments, completing worksheets, maintaining journals, and taking field trips. Each of these activities was designed to accommodate the various developmental levels of elementary students. Because the focus of the program was on science and mathematics, all intervention activities were related to those disciplines.

Staff Information

Elchurch employed approximately six staff members, ages 25-45. The two males and four females were all African American educators (in-service or retired). Special training sessions prepared each instructor for the Elchurch program. Each of these two sessions focused on the program's goals, objectives, activities, rules and regulations, and other concerns. According to the program coordinator, the younger, more mobile staff members were less likely to plan to continue with Elchurch, while the older members were more likely. Compensation varied from $20 per hour to $30 per hour and was based on the nature of each staff member's contribution. All staff were paid. The program coordinator was a full professor in the biology department at the administering university.

Financial Information

To support its $8,000 per year budget, Elchurch required a nominal weekly fee for each participant. The amount of the weekly fee was not disclosed. Scholarships were available for students who were unable to pay.

Program 3—Enviroyear

Administered by a Master's II, state-funded university in the Piedmont region of South Carolina, the Enviroyear program offered middle school students an opportunity to prepare for undergraduate education while emphasizing environmental science. Supported by a five-year federal initiative, the overall goal of the program was to help at-risk students in grades 7-8 enroll, persist in, and graduate from an institution of higher learning. In its third year of operation, Enviroyear represented one university's efforts to achieve this goal, while using environmental science, mathematics, and technology as the vehicles of choice. The fictitious name highlights two important qualities of the intervention program—its environmental science (Enviro) focus and the use of a year-round (year) program to achieve its goals. Observations and interviews during a visit to the summer program, the Program Coordinator Questionnaire, and artifact data provided the following information about the Enviroyear program.

Program Objectives

The program coordinator identified the following objectives of Enviroyear: (a) to prepare middle school students for undergraduate education, (b) to improve general progress in math and science classes, (c) to increase students' readiness to meet the objectives of the Enviroyear program, and (d) to obtain suggestions and ideas for future improvements. These four objectives were embraced by the overall goals of the initiative to which Enviroyear belongs: to increase educational expectations for participating students; to provide an enriched, stimulating, and active learning environment; and to increase student and family knowledge of post-secondary opportunities and financial aid options.

The Enviroyear staff learned of the program objectives through formal and informal meetings, a parent orientation, and through the evaluation of their written curricula. Recruitment and orientation sessions informed the parents and participants of the objectives. Additionally, the intervention activities reminded students of the goals of the program. The objectives were measured by surveys, scores on state-mandated achievement tests, and action research. The action research involved an analysis of student participation, student work, and interviews with students, instructors, and mentors. The surveys and test scores, though collected by the program coordinators, were evaluated by the funding source. The program coordinators conducted the action research.

Program Format

Enviroyear operated during the school year, as well as in the summer. The school year component met one day per week for 16 Saturdays during the school year. Each Saturday meeting was from 9:00 a.m. until 2:00 p.m. The summer component was a 15-

day non-residential program, with meetings from 9:00 a.m. until 4:00 p.m. Meetings, in June, lasted from 9:00 a.m. until 3:00 p.m. The summer component targeted rising eighth grade students. These students, as eighth graders, were invited to participate in five Saturday experiences during the following fall semester. A second Saturday component occurred during the spring semester, and invited current seventh grade students. Hence, Enviroyear students participated in three different components—spring semester of seventh grade, summer before eighth grade, and fall semester of eighth grade.

Program Location

Enviroyear, administered by a Master's II level university in South Carolina's Piedmont region, utilized the university as its primary site. The science classes occurred in fully equipped science labs, and the instructors had complete access to the science equipment and materials. Other classes used computer labs, technology-enriched classrooms, and the physical education facilities (swimming pool and gymnasium), and all meals were served in the university cafeteria.

Field trips to places such as a lake, a deaf community, state parks, a ropes course, and a Spanish-speaking neighborhood and restaurant allowed the Enviroyear participants to visit local areas. Trips to other colleges and universities in the South Carolina exposed students to small, mid-sized, large, historically Black, public, and private institutions of higher learning.

Target Population

Enviroyear targeted seventh grade students at the eligible public middle schools from the five counties surrounding the administering university. The partner schools were chosen because of their high free/reduced lunch constituencies. The program targeted at least 75% free/reduced lunch recipients and a high minority population.

According to the program coordinator, Enviroyear was designed for students with potential, and represented neither the top nor bottom 10% of their class' academic abilities.

Recruitment and Selection

Enviroyear recruited participants from the five partner middle schools in the five counties surrounding the administering university. Enviroyear invited selected seventh grade students or the entire seventh grade class to attend a recruiting fair at each school. A selection committee comprised of a team of Enviroyear staff members and teachers and principals from the partner schools reviewed the applications to choose the participants. Information included during the application process included free/reduced lunch status, race/ethnicity, language minority status, disability status, and school district representation. Additional information included scores on the state-administered achievement test, letters of recommendation from guidance counselors and teachers, and letters of participation from parents. Enviroyear met its goal to serve at least 75% free/reduced lunch recipients and mostly minority (African American) students.

Generally, all students who applied (usually 65-70 students) were selected to participate in Enviroyear. By the end of the 16 Saturdays in the spring semester, the number of participants had dropped to 45-50. The summer component served approximately 30 students.

Intervention Activities

The Enviroyear summer component utilized a variety of activities, including hands-on science activities, technology-based experiences, design projects using robotic Legos®, leadership activities, problem-solving drills, physical education and exercise studies, and Spanish and sign language classes. Two cohorts of morning sessions rotated through project-based learning in science, mathematics, technology, and team-building activities as the students participated in hands-on science activities. One science teacher took advantage of the environmental theme and, with her classes, examined ecosystems, the environment, and water. Using modified versions of nationally recognized curricula, such as Project Wet, Project Wild, Project Wild Aquatic, Project Learning Tree, Tribes, and the National Science Curriculum Project for High Ability Learners, the Enviroyear participants learned about watersheds, oil spills, wetlands, water quality testing, and other environmental concepts from one science instructor. Another science instructor, on the other hand, preferred physical science topics such as light and optics. Field trips to a local lake, waste management and water treatment plant, and an outdoor wilderness challenge supplemented all of these science activities. Other field trips, to various colleges in the state, allowed opportunities for guided tours, admissions presentations, and field studies to complement previous Enviroyear activities.

While the morning sessions offered an emphasis on science, the afternoon meetings highlighted leadership and academic survival skills, creative problem solving, exercise studies, and more team-building activities. During the leadership module emphasis was placed on careers, career development, social aspects of success in college, conflict resolution, self-esteem, and assertiveness training. Three cohorts of students rotated through these experiences. Participants in Enviroyear’s summer component were expected to participate in five Saturdays during the following fall semester. These additional Saturday experiences included hands-on activities at local parks, state parks, and other outdoor education areas, as well as hands-on activities on the university’s campus.

Enviroyear offered a 16-week Saturday program during the spring semester for seventh graders. This Saturday program highlighted the sciences of languages and personal skills. Three languages, Spanish, sign, and computer were the focal points. Participants learned introductory Spanish and became familiar with the Hispanic culture. Additionally, they learned American Sign Language, and visited a school for the deaf to hone their skills. Participants used Lego® Robolabs and other computer technology to improve their programming skills. Six field trips, including three service-learning opportunities were included in the Enviroyear Saturday component for seventh graders.

In response to observations of past Enviroyear programs, the current staff decided to slow the pace of the academic portions to better meet the abilities and needs of the participants. They chose to combine some of the social and academic expectations and integrate the curriculum to benefit the students.

Staff Information

During the summer, Enviroyear employed approximately 19 staff members including 7 instructors, 4 professors, 6 mentors, and 2 co-directors (program coordinators). Of the seven instructors, 4 were female, and all were middle school math and science teachers. They were selected based on their reputations for leadership and knowledge in their fields, creativity in their pedagogical approaches, and their desire and ability to work with at-risk middle school students. The professors, an African American couple, one White male, and one White female, served as guest lecturers and permanent members of the staff. They were recruited from the administering university and a local technical college. The selection criteria for the professors were similar to that of the instructors. Six student mentors, one Black male, two Black females, and three White females, were chosen from the university's leadership program and a group of teaching fellows. Both program coordinators for Enviroyear were assistant professors at the administering university—one in the school of education, and the other in the school of physical education and exercise sciences.

The staff members received training via meetings with the program coordinators and their involvement with various administrative duties. Unless they demonstrated an inability to work effectively within the Enviroyear program, each staff member was invited to participate in future years/sessions. Compensation varied based on the contribution of each staff member to the program, and all staff were paid.

Financial Information

Enviroyear operated free of charge to participants and offered no stipend. The program's backing came from the state's commission of higher education, with funds from a federal initiative. The amount of funding provided by the initiative was not available.

Program 4— SumSpace

Administered by a Doctoral Intensive level university in the lower Savannah Region of South Carolina, SumSpace offered middle and high school students an opportunity to interact with space science. The administering university was also recognized as a historically Black institution. Supported by a federal agency and housed at a campus-based space center, the overall goals of the program were to introduce space science to middle and high school students and create an interest in the field. Since 1998, the program aimed to challenge students while exposing them to the scientific learning process. The fictitious name highlights two important qualities of the intervention program—the summer format (Sum) used to deliver the intervention and the program's emphasis on space science (Space). Artifact data and personal communication with the program coordinator provided the following information about the SumSpace program.

Program Objectives

The study identified the following objectives of SumSpace: (a) to introduce students to space science and stimulate their awareness of relevant careers, (b) to cultivate an ongoing interest in science in general and the universe in particular, (c) to expose students to scientific research, including how data are collected and analyzed, (d) to provide skills/techniques that allow students to compete in science fairs, participate in workshops and conferences on a state and national level, (e) to provide students with hands-on experiences using the telescope, (f) to enhance skills and knowledge through interactive lab activities, (g) to provide exposure to undergraduate science majors and practicing experts in the field, (h) to gain experience as team members while developing a better understanding of the solar system, (i) to instruct teachers on the use of the Internet as a tool to explore space, and (j) to develop a resource web page on the solar system.

The program objectives were shared with parents and participants via a web site, brochures, and other print materials. How the objectives were articulated to the staff was unclear. Additionally, the methods used to measure the objectives were not clarified.

Program Format

SumSpace operated as two overlapping summer programs. While one program offered science teachers (grades 7-9) an opportunity to interact with college science faculty and students, the other afforded students (grades 7-9) similar experiences. Both programs emphasized space science and computer technology. The teacher program lasted 13 days, while the student program operated for 10 days. Both programs used 8:00

a.m. until 3:15 p.m. as the time allotted for academic study. After that time, the teachers left campus and the students participated in recreational experiences. The student program was residential, though participants were not permitted to live on campus during the weekends.

SumSpace selected five teachers for a unique arrangement of program participants/staff. Five middle school or ninth grade science teachers were invited to participate in the SumSpace teacher component. Only one teacher from a school was eligible. The first three days of the teacher component consisted of a preparation workshop designed to help teachers hone their astronomy skills and knowledge. The workshop introduced the teachers to inquiry-based, hands-on activities that were based on state and national science standards. The remainder of the program involved two weeks of intensive space science study during which the teachers supervised the student experiences. The teachers and students were divided into teams to achieve the goals of SumSpace. Unless otherwise noted, further discussion of SumSpace refers to the student component only.

Program Location

As previously mentioned, SumSpace was administered by a Doctoral Intensive level university South Carolina’s lower Savannah region. The university was identified as a historically Black institution of higher learning. The program activities occurred in the science building on the campus of the administering university. The participants had access to the Internet, science equipment, and large work areas for their hands-on activities. Additionally, the students resided in campus housing and utilized the cafeteria. Off-campus trips to movie theaters, bowling alleys, and shopping centers were provided for evening excursions.

Target Population

SumSpace targeted minority students, particularly African Americans. Participants were required to attend a South Carolina school and be enrolled in grades 7-9. The program could effectively accommodate 20 students.

Recruitment and Selection

SumSpace recruited participants from the entire state of South Carolina. To be considered, students were required to submit an application, essay, and registration fee. The application asked for data including grade point average, awards and achievements, and career interest. A 250-word essay supplemented each application, and described the applicant's career objectives, interest in science, and how SumSpace could be an asset.

Intervention Activities

SumSpace students resided on the university's campus (except on weekends) and participated in a variety of activities that were designed to motivate them to pursue careers in space science. Some of these activities included hands-on science experiments, Internet use, building a model of the solar system, building a model comet, solving space-related problems, visualizing in 3D, creating a resource web page on the sun and planets, observing the summer sky, visiting the campus planetarium, and learning about various space science careers through discussions with undergraduate science majors and experts. Leisure activities, such as bowling, organizing a talent show, and viewing movies were planned for the evenings.

Staff Information

For two weeks, the teachers served as SumSpace staff members, and were paid a stipend of $715 upon full completion of the program. They led the activities that supported the goals of the student component. Comparable to the student component, the teacher component recruited minority, particularly African American, science teachers in South Carolina. Training for SumSpace involved a two-hour orientation session in May and the three-day preparation workshop. Other staff members included undergraduate science students who served as mentors to the seventh-ninth grade students. The compensation provided to the mentors was unclear. The program coordinator was a staff member of the space center that was housed at the university.

Financial Information

Though SumSpace required a registration fee of $60, participation was free of charge. Students who were not accepted to the program were refunded their money. No stipends were offered to the student participants. The National Aeronautics and Space Agency (NASA), through a campus-based research center, provided the primary funding for SumSpace. Information regarding the exact amount of funding was not available.

Program 5— SpringSat

Administered by a Master's I, historically Black, state-funded university in a residential area of Baltimore, Maryland, the SpringSat program offered to students an opportunity to become more interested in science, engineering, and mathematics. In operation since 1989, and supported by federal funding, the overall goal of the program was to develop more science, engineering, and mathematics students. The fictitious name highlights two important qualities of the intervention program—its spring semester (Spring) duration and its use of Saturdays (Sat) to offer intervention. A program coordinator questionnaire and artifact data provided the following information about the SpringSat program.

Program Objectives

The program coordinator identified the following objectives of SpringSat: (a) to increase student performance on national and state performance tests, (b) to increase student motivation and performance in science, engineering, and mathematics (SEM), and (c) to increase parent participation and involvement in the development of SEM students.

Training sessions and weekly meetings provided the staff with an opportunity to learn the objectives. Parents and participants attended a pre-program workshop, during which the objectives were articulated. To measure the objectives, SpringSat staff administered pre- and post-tests. Additionally, parent interviews were used to garner information about school achievement, work habits, and test scores. The program staff and coordinators facilitated the assessment.

Program Format

SpringSat operated during the spring semester of the school year. The program met for six hours each on 10 consecutive Saturdays.

Program Location

As aforementioned, SpringSat was administered by a Master's I, historically Black university in a residential area in Baltimore, Maryland. All of the program activities occurred on campus. The specifics of each room varied with each session, therefore that information was unavailable.

Target Population

SpringSat targeted inner city, minority students in grades 3-12. Due to the historical Black nature of the administering university, and the composition of the city, most participants were African American. The broad nature of the target population allowed the program to serve multiple ability levels, and information regarding the number of participants was not available.

Recruitment and Selection

SpringSat used relationships with local schools to recruit its participants. Because no academic requirement was stipulated, the program operated on a first come, first served basis. Students who had previously participated were invited first, and nearly half of all students returned each year.

Intervention Activities

SpringSat utilized a variety of activities, including mathematics and language arts classes, with an emphasis on critical thinking, writing, and speaking. Additionally, participants attended computer classes and completed engineering design projects. Because the program served grades 3-12, SpringSat provided experiences appropriate for a wide range of developmental levels.

Staff Information

SpringSat employed several staff members, most of whom were African American. Though many of the staff were female, some were male. A five- day session offered specialized training for SpringSat staff. The program coordinators, who had years of mentoring and tutoring experience, facilitated the training. Most staff members were volunteers, though some were paid $200 at the end of the program. The program coordinator was an associate professor in the school of engineering.

Financial Information

SpringSat operated free of charge to participants and offered no stipend. The program's funding came from a coalition of engineering schools supported by the

National Science Foundation. Information regarding the amount of funding was not available.

CHAPTER 5
RESULTS FOR RESEARCH QUESTION #2

The study identified 46 science intervention programs administered by the 42 public universities in South Carolina, Georgia, Maryland, and the District of Columbia. Of those 46 programs, 15 targeted and recruited minorities and met the other criteria to be included in the study. Five of the 15 eligible programs participated in the study. An investigation of the descriptive and interpretive data collected for the Research Question #1 resulted in an evaluation of the underlying premise of existing science intervention programs. The following discussion answers Research Question #2: What does a cluster evaluation of existing science intervention programs reveal about their intent and efforts?

The data collection categories associated with each science intervention program (i.e., program objectives, program format, program location, target population, recruitment/selection, intervention activities, program staff, and financial information) organized the analysis. A data analysis tool (see Appendix F) was used to compare the standards for science intervention programs developed by the researcher to the collected data. See Chapter 3 for a thorough discussion of the standards used for comparison. This chapter outlines the analysis of each data collection category, as well as an evaluation of each analysis. In accordance with the essence of cluster evaluation, the following analyses and evaluations refer to the cluster of science intervention programs rather than individual programs.

Program Objectives

Program objectives outlining the goals of each science intervention program determine the format and scope of the program. The objectives identify the scope of the intervention activities. According to the standard, science intervention programs should address at least two of the following: science skills, science content knowledge, attitudes toward science, and science-related careers. Ideally, all four components should be addressed. Program staff, parents, and participants should be aware of the objectives prior to the start of the intervention. To exceed the standard, staff should be reminded of the objectives via regular meetings throughout the course of the program, and parents should first learn of the objectives at a recruiting session. The standard suggests that the objectives should be measurable and measured via traditional, paper-pencil methods. An internal evaluator should facilitate program evaluation. Ideally, an external evaluator should employ alternative techniques such as interviews, observations, and performance tasks.

Analysis

Each of the five programs in the cluster identified science content knowledge as a major component of their objectives. Three programs also emphasized attitudes toward science, but science-related careers and science process skills were not well represented in the cluster. Objectives for science-related careers and science process skills were each identified for only two programs. All programs outlined effective means to articulate their objectives to staff, parents, and participants. Though three programs reiterated their objectives to staff during the course of the programs, only one offered the same reminder to parents and participants. Of the 23 objectives stated by the programs, 83% were measurable, and three of five programs instituted appropriate evaluation tools to assess the majority of their objectives. One program had unclear evaluation methods, and the other four programs met the minimum standard for measuring objectives.

Evaluation

Though attitudes toward science remain an important focus of science intervention programs, its overemphasis occurred at the expense of science skills and science-related careers. Research indicates that Black students tend to express positive attitudes toward science but demonstrate low achievement in science (Anderson, 1989). Consequently, as the cluster highlighted attitudes toward science and science content knowledge, it understated the importance of science skills and science-related careers. The programs' aims did not enable Black students to improve skills with science processes and equipment or increase their awareness of pertinent career opportunities. Although the cluster emphasized science content knowledge, the application of such knowledge (i.e., science skills and careers) was minimal. Accordingly, the cluster did not provide the much-needed relevance to encourage participants to view science as an important entity in their lives. Students were not granted the opportunity to answer the following questions, first posed in Chapter 3: What are the skills of science? How can these skills be used in all aspects of my life? And how can my skills, knowledge, and attitudes be used to benefit society in the form of a career?

The cluster used traditional assessment methods, such as pre- and post tests, surveys, and worksheets to measure program objectives. These structured evaluation tools did not consider the achievements of participants with various learning modalities. Though traditional methods, employed by an internal evaluator, served the basic purpose of measuring objectives, alternative methods and an external evaluator would have provided a richer perception of the effectiveness of the programs.

Overall, the cluster's objectives were constructed in a manner that created gaps in program emphasis. The assessment tools perpetuated these gaps by not providing opportunities for participants to demonstrate their expertise and/or deficiencies in science content knowledge, science skills, attitudes toward science, and science-related careers. The assessments were appropriate for the programs' stated objectives, but the use of limited tools affected the extent to which the objectives could be measured. More comprehensive assessments could have revealed gaps in program emphasis. This information could have been used to develop additional objectives to meet the needs of the students.

In the area of program objectives, the cluster's effort can be deemed good. The programs presented measurable objectives, articulated these objectives to staff, parents, and participants, and measured the achievement of the objectives. This strength was countered by the under-inclusion of science process skills and science-related careers.

Program Format

Program format refers to when a program operates (after school, during school, Saturdays, and/or summer), its duration, and the length of each meeting. Program format should be closely linked to program objectives, in that the goals of the program determine its needs, which require a particular design. Science intervention programs should be in constant contact with their participants. Daily and weekly meetings allow for effective intervention, whereas long breaks between meetings may lessen the success of the program. The standard suggests that programs offering concentrated sessions, such as summer components, should meet on a daily basis. This component should be at least a two-week, nonresidential session. Ideally, the summer session should be at least three weeks and residential. For programs that offer widespread components, such as yearlong sessions, students should meet on a weekly basis. According to the standard, students should be able to continue their participation for one additional year and/or session. Ideally, students should continue their participation throughout the duration of their schooling.

Analysis

Four of five programs offered activities that were clearly consistent with their objectives. All programs provided frequent meetings with participants. The summer components met on a daily basis for at least two weeks, and the yearlong and semester components met weekly for at least 10 weeks. Three programs invited students to continue participation in future years/sessions, whereas one program was discontinued. For obvious reasons, these students were not able to remain involved. The nature of one program deemed it unlikely to allow repeat participants, but this information could not be corroborated.

Evaluation

Through the various designs of the intervention programs examined in this study, the cluster acknowledged the correlation between program objectives and program format. The programs were not designed arbitrarily, but in fact, represented program developers' knowledge of the potential benefits of certain activities. The "educated intuition" of the program developers, as described by Clewell (1989, p. 99), appeared to be an effective means of providing opportunities for students that were consistent with the scope of the programs. Additionally, science intervention programs allowed students to continue their participation in future sessions/years. The prospect of continued involvement imparts consistency in students' academic growth and personal relationships with peers, mentors, role models, science content, and science-related careers. Overall, the cluster offered sound program designs that were related to the stated objectives of each program. The availability of consistent involvement allowed students to remain motivated, inspired, and positively affected by the intervention programs. Consequently, the cluster presented a strong effort with regard to program format.

Program Location

Although the sites of science intervention programs vary, programs generally utilize local schools, university facilities, community centers, or neighborhood churches. According to the standard, science intervention programs should be conducted at community sites or schools, and be supplemented by the use of university resources and facilities. Ideally, these programs should occur in community sites and investigate community-related issues using local and university resources. Programs housed in university facilities should engage students in experiments, projects, and activities within the community at least twice during the program. Ideally, all science intervention programs should use community sites for most of their activities and field trips.

Science intervention programs require the use of facilities that foster hands-on science activities. Hands-on activities can be fostered by large tabletops, work space, sinks, uncarpeted floors, comfortable seating, comfortable temperatures, and adjustable lighting. Furthermore, science intervention demands science equipment and supplies. The standard suggests that all programs should have ready access to an environment that fosters hands-on activities and provides access to science equipment and supplies. To exceed the standard, programs should have a fully equipped laboratory for students use.

Analysis

Three of the programs in the cluster were housed in university facilities, and the other two utilized community sites. One program actually used four sites, two middle schools, one church, and one girl-oriented youth center. The other program was housed at a church. Of the programs housed on university campuses, only one visited community sites for field trips or to conduct science activities. As a result of the program with four locations, the number of sites included in the cluster increased to eight. Five of eight program sites fostered hands-on science activities, however an analysis of the community-based sites versus university-based sites revealed an interesting difference. Programs housed in the community failed to provide adequate access to science equipment and supplies for student use. The university-based programs supplied the necessary equipment and resources for students.

Evaluation

While local schools and community sites provide convenience and familiarity to participants, university facilities have easier access to resources for conducting science experiments, visiting laboratories, and meeting scientists and college students. For residential programs, university facilities offer room, board, and other amenities. Implicitly, programs housed at universities perpetuate the notion that science is a remote endeavor, and that one must go elsewhere to see or do science. Community sites counter this idea by offering an accessible perception of science. As such, the cluster attempted to challenge the notion of remote science, but did not provide enough experiences for students to view their communities as sites for seeing and doing science. The repeated use of universities to house the programs without adequate community-based field trips and projects perpetuated the aforementioned idea. Within the community-based programs, the lack of science equipment, materials, and other characteristics that foster hands-on activities also perpetuated the remote nature of science. Although these programs included neighborhoods and communities in science through their physical locations, inadequate resources impeded the perception change from remote science to accessible science. Overall, the cluster demonstrated a weak effort regarding its portrayal of accessible science as evidenced by program location.

Target Population and Recruitment/Selection

Science intervention programs determine the population they aim to serve, and identify recruitment and selection strategies to achieve their goal. Programs recruit and select in accordance with the target populations. Some programs specify important criteria, such as race/ethnicity, gender, grade point average, intelligent quotient, teacher recommendations, proficiency or interest in science, achievement level, socioeconomic status, geographical location, and/or school enrollment. Other programs operate on a first-come, first-served basis. Science intervention programs utilize various recruiting strategies, including partnerships with local schools, churches, and community organizations and word of mouth.

According to the standard, science intervention programs should recruit with a wide range of academic performance levels. Gender parity should be evident in all programs unless a program specifically targets one gender. The composition of the programs should reflect the target population of the local community, but not to the omission of other races/ethnicities. A small participant to instructor ratio should be maintained at 8 to1, or ideally, 6 to 1. Science intervention programs should be free for participants, or charge a nominal fee. Fee-based programs should provide scholarships or other financial assistance. The standard suggests intervention programs utilize strategies to recruit students and parents, not just parents. Unless a specific area has been targeted, science intervention should serve a wide variety of communities, neighborhoods, and schools.

Analysis

All of the science intervention programs in the cluster selected participants representing a range of academic performance levels. None of the programs included students on either end of the ability spectrum—gifted/talented and students with extreme learning challenges. None of the programs was gender-specific, but only one program coordinator was able to identify the percentages of participating girls and boys. Four of five programs did serve their target populations, with one program failing to attract minorities other than African Americans. With two programs not clarifying their participant to instructor ratio, the ability of the cluster to provide adequate opportunities for relationship building between students and staff could not be determined. Three programs did not charge a fee to participants, while one program required a refundable registration fee. One program charged a weekly fee, but offered scholarships to those in financial need. Though the programs served a wide variety of communities, neighborhoods, and schools using various recruitment strategies, the focus of their recruitment—parents, students, and/or families—was not clear.

Evaluation

The science intervention programs in the cluster selected students who represented a range of ability levels. All of the programs targeted and served minority, particularly Black students. Despite serving both genders, the cluster was unaware of the number of males and females in the programs. The program coordinators likely collected such information, but did not or could not access it readily. This indicated a lack of interest in gender issues related to science intervention programs. Program coordinators should be aware of potential gender differences in the effectiveness of their intervention. Minority males and females may respond differently to intervention efforts. Coordinators who document gender demographics and analyze the effects of their programs on males and females can be better equipped to provide experiences that benefit their participants. Furthermore, they should correlate the gender demographics of their participants to those of the role models and mentors they employ. The program coordinators provided ambiguous information regarding participant to instructor ratios. Closer attention to this matter could shed light on the effectiveness of the cluster's ability to maintain a low participant to instructor ratio. Overall, the cluster exhibited a strong effort concerning the inclusion of a range of academic performance levels, and a weak effort regarding gender parity and participant to instructor ratios.

Intervention Activities

"The effectiveness of approaches and strategies depends on a knowledge of the target population and on the application of theoretically sound practices" (Clewell et al., 1992a, p. 98). According to the standard, program activities should be consistent with the objectives. As such, they should incorporate some combination of science process skills, science content knowledge, attitudes toward science, and science-related careers. Additionally, programs should incorporate a variety of activities, including hands-on experiments, design projects, interdisciplinary lessons, creative and critical thinking, worksheets, oral presentations, and individual and group work. The standard requires that students be actively engaged in hands-on activities at least three times per week for summer components and one per session for yearlong components. Also, one long-term design project should be incorporated into summer and yearlong sessions. Exposure to mentors and role models should be an integral part of intervention activities. The standard suggests that these mentors and role models should be college students and professionals who represent the fields of interest, genders, ethnicities, and backgrounds of the student participants. Programs should offer mentors in the form of diverse staff members who interact with students at each session. Role models should be guest speakers, staff, and biographical studies representing a diverse group of people. They should be presented at least twice for summer programs and every three meetings during yearlong sessions. The intervention activities should introduce students to a variety of science-related careers via field trips, guest speakers, biographical studies, and discussions. According to the standard, career awareness should include examples of professionals, descriptions of the type of work involved, and discussions related to preparing for such careers.

Analysis

The cluster provided intervention activities that were consistent with the program objectives. These program activities were hands-on and traditional, and incorporated group as well as individual work. The cluster provided ample opportunities for students to engage in design projects during summer and yearlong components. Three of the programs in the cluster exposed students to mentors and role models. Though three of the programs did not identify career awareness as an objective, they did emphasize science-related careers through the use of role models, guest speakers, and presentations during field trips.

Evaluation

The cluster's use of diverse intervention activities was valuable for students with various learning modalities. Students' exposure to mentors and role models complemented the other intervention activities. As previously discussed, most of the programs did not identify career awareness as an objective, yet they did emphasize science-related careers. This resulted in competing perceptions of the cluster. On one hand, the secondary nature of the career-related activities did not detract from the importance of science-related careers. Rather, it implicitly underscored the application of the science skills, knowledge, and attitudes that were explicit to the programs. A planned focus on careers would likely result in more connections made between students' interests and related professions, but the unplanned attention was positive. The program coordinators valued the peripheral inclusion of science-related careers and offered the exposure as an unintended bonus. On the other hand, the lack of an intended focus on science-related careers resulted in an undetermined quality of student exposure. Although participants learned of science-related careers, the peripheral treatment perpetuated the underrepresentation that currently plagues the science community. The ultimate goal of science for all is to increase science literacy and thus affect the participation of females and minorities in science-related careers. The cluster's lack of planned experiences to reach this goal served a counterproductive purpose that could cause one to question the intentions of the programs. With regard to providing a variety of intervention activities and mentors/role models, the cluster demonstrated a strong effort. Concerning career awareness, however, the effort was fairly implemented but poorly designed.

Program Staff

An analysis of program staff can provide insight regarding the program's ability to meet the needs of the target population. The program staff should represent, but not be limited to, the gender, race, and ethnicity of the student participants. According to the standard, the staff should have an opportunity to work with the program for at least one additional year. This provides continuity for the program, as well as the students. Staff should be trained prior to the start of the program. This intensive training should highlight the program's goals, purposes, and objectives, as well as program policies, activities, and ideals. According to the standard, the training should last at least four hours. Staff members should be compensated either financially or academically. The majority of the staff should earn a stipend, salary, or course credit. The motivation of compensation may offset the lack of commitment or high turnover that volunteerism or a requirement may produce.

Analysis

All programs in the cluster utilized staff members who represented, but were not limited to, the demographics of the target populations. Staff members were able to continue their participation for at least one additional year. Adequate training in all five programs prepared the staff members for the upcoming intervention activities. All programs in the cluster provided financial compensation, often quite competitive, to their staff.

Evaluation

The cluster's use of training, continued participation, and financial compensation cultivated the needs of the staff, thus enabling them to concentrate on the needs of the students. Intensive training sessions, frequent meetings, handbooks, and open communication provided the staff with the necessary tools for intervention. The staff members for each program were well prepared. The programs, with the possible exception of one, invited their staff to continue working in future years. The sustained involvement of staff and students allowed lasting relationships to develop. As these relationships grew among the staff, students, and families, the strength of each program similarly grew. The influence of these affective factors cannot be overlooked or discounted when determining the impacts of science intervention programs. Overall, the cluster presented a strong effort in selecting, preparing, and compensating staff members.

Overall Evaluation of the Cluster

Overall, the cluster exhibited many strengths related to the implementation of science intervention programs. These strengths, though executed differently for each program, included: (a) sound, measurable objectives; (b) articulation of program objectives to staff, parents, and participants; (c) frequent contact during sessions; (d) the potential for continuous involvement of staff and participants; (e) participants who represented a range of academic performance levels; (f) programs that served their target group; (g) the participation of various communities, neighborhoods, and schools; (h) effective recruitment strategies as evidenced by the congruence between target population and actual participants; (i) financially inclusive programs; (j) a variety of intervention activities; (k) intensive training for staff, and (l) duly compensated staff members.

In addition to these accomplishments, the cluster exhibited areas that could use improvement. The following lists the facets of the cluster that could benefit from further development: (a) inadequate focus on science-related careers and science process skills, (b) insufficient use of communities as sites for doing and seeing science, and (c) meager intervention strategies for younger students. Other issues, though not as glaring, should also be considered. These include: (a) the use of narrow evaluation tools to assess the accomplishment of the program objectives, (b) lack of attention to gender equity for participants, and (c) poor participant to instructor ratios.

As represented by the five programs in the cluster, science intervention programs for Southern Black students revealed good intentions, but with some limitations. The strengths demonstrated effective structural components, such as program format, recruitment and selection, and intervention activities, whereas the weaknesses stemmed from nonstructural, yet equally important factors. As a metaphor, consider the construction of a home. When building a home, the physical structure must be supportive and safe, and is usually attractive. The building, once standing and covered with a roof, serves its basic purpose, though other entities—some considered necessities and others viewed as luxuries—must be in place before the home can be inhabited. These entities include running water, electricity, smoke detectors, doors with locks, banisters, security systems, and carpet or finished floors.

In terms of science intervention programs, the cluster utilized a strong foundation and frame. Its metaphorical house was structurally sound and served its primary function. The program objectives, formats, and intervention activities were effective. Many essential items needed to dwell in the house, however, were lacking. Although the house can be used, it does not offer the security and comfort the amenities provide. The inclusion of these components should not be regarded as unnecessary perks. They are, in fact, necessary to providing a comprehensive environment that supports the participation of Blacks in science. This supports the purpose of the national science for all initiative.

Gaps in Program Emphasis

The cluster stressed positive attitudes toward science, without sufficiently highlighting science-related careers and science process skills. Continually promoting positive attitudes toward science without exposing students to practical uses of science does little to reduce the underparticipation of Blacks in science. Of what value is science intervention if students do not develop an interest in pursuing science as a profession? A focus on attitudes and science content does not provide a large enough platform for students to utilize their knowledge. They must be exposed to the science process skills, which will prepare them to become doers of science, rather than bystanders. If science intervention programs aim to produce students who hold positive attitudes toward science, and possess increased knowledge of science content, then ignoring science process skills and science-related careers would be justified. Science intervention, via science for all, however intends to counter the underrepresentation of minorities and females in science. As a result, intervention programs must purposely and adequately emphasize science process skills, science content knowledge, attitudes toward science, and science-related careers.

Insufficient Use of Community Sites

The cluster attempted to challenge the notion that science is a remote endeavor and that one must leave the community to see or do science. Despite its attempt, the cluster did not provide enough relevant, hands-on, and community-based science experiences. Students participated in science activities that were not derived from local issues or dilemmas. These science experiences, though interesting and informative, did not address the concerns of the community. Thus, the cluster sustained the inaccessible perception of science. This bears importance because students who believe science is an unattainable entity will not be motivated to pursue science. Likewise, youth who do not believe science affects their lives will not be interested in doing science. Science intervention programs can provide opportunities for students to see the influence of science knowledge, study, and interest on local areas. Students need to be exposed to the problems that inspire scientific investigations. They need to understand that people use science to answer questions about the world around them, including the local area.

Meager Intervention Strategies for Younger Students

The cluster did not provide sufficient science experiences for elementary students. Science for all should not begin in middle school. Early, positive, and relevant experiences in science can stimulate students to continue their participation. Science intervention programs that do not include younger students fail to tap into a large source of potential science-related professionals. The cluster contributed to this slimming of the science pool by not addressing the needs of younger students. What purpose does middle and high school intervention serve when elementary students are omitted? Why should science intervention wait until students are in middle school and pursuing other interests? Why not provide relevant, hands-on science experiences to young children when they are displaying their curiosity? The cluster's poor attention to young students served to limit the number of students who could eventually pursue science-related careers.

CHAPTER 6
RESULTS FOR RESEARCH QUESTION #3

The study identified 46 science intervention programs administered by the 42 public universities in South Carolina, Georgia, Maryland, and the District of Columbia. Of those 46 programs, 15 targeted and recruited minorities and met the other criteria to be included in the study. Five of the 15 eligible programs participated in the study. An investigation of the descriptive and interpretive data collected for Research Question #1 resulted in an evaluation of the underlying premise of existing science intervention programs. The evaluation was a response to Research Question #2. The following discussion answers Research Question #3: How can existing programs inform the development of models for science intervention programs for Black students?

Each of the programs in the cluster, other programs familiar to the researcher, and empirical evidence informed the development of two models for science intervention programs. The models represent two different approaches to science intervention, strengthened by different aspects of the cluster programs and addressing the areas of improvement discussed in Chapter 5.

Model #1

Model #1 exemplifies a university-administered program that services its local area. The program targets rising sixth-graders and follows them throughout their middle school matriculation. In accordance with the goals of science for all, a university-wide intervention program for middle school students can benefit the participants, the university, and the local community. This model provides a gateway through which underrepresented groups can enter science-related careers.

Program Objectives

The objectives of Model #1 include emphases on science process skills, science content knowledge, attitudes toward science, and science-related careers. They incorporate cognitive (i.e., knowledge, understanding, inquiry, and processes), affective (i.e., attitudes, values, and habits of mind), psychomotor (i.e., physical skills), and social (i.e., communication and interaction) learning objectives. The well-rounded approach of Model #1 allows students to identify the relevance of science in their lives, as well as answer questions including: What are the skills of science? How can these skills be used in all aspects of my life? What science knowledge is important to know at my developmental level? How can my science literacy be used to make informed decisions everyday of my life? How do I feel about science? How do I feel about myself as a doer of science? What are my perceptions of science? And how can my science skills, knowledge, and attitudes be used to benefit society in the form of a career?

Model #1 articulates the program objectives to staff members during a one-week pre-program training workshop. Additionally, these objectives are thoroughly discussed in a program handbook, and reiterated at bi-weekly meetings during the course of the program. Parents and participants learn of the objectives during recruiting sessions, orientation meetings, and via a parent/participant handbook.

To assess the achievement of the objectives, Model #1 uses surveys, pre- and post-tests, interviews, and performance measures. Program staff administers these measures at the end of each program cycle. That is, students who have completed one summer and one academic year are assessed. These annual assessments can provide information regarding the effectiveness of each cycle, and can serve as formative evaluation tools. At the end of three cycles, an outside evaluator should conduct extensive reviews of the program using a variety of quantitative and qualitative evaluation techniques. An external summative assessment can determine the impact of Model #1 on students who have remained with the program for three years.

Program Format

Model #1 uses its objectives to develop its format. Students enter the program during the summer before their sixth-grade year and continue with a yearlong intervention. The three-week residential summer component, designed to provide relevant laboratory and field experiences, exposes program participants to a number of science fields. The following school year comprises four-hours of intervention each week. These four hours can be arranged in two after school sessions or one Saturday session. Model #1 strongly encourages students to participate throughout their middle school years.

Program Location

During the summer component, Model #1 utilizes a university campus as its primary site. This provides students with the amenities of a residential program, as well as ready access to science facilities and equipment. In addition to the dormitories and cafeterias, students use laboratories, meeting rooms, and other university facilities. Though the program is housed at the university, students also participate in off-site, community-based projects. A variety of field trips provide other means for students to experience different locations.

The school year component is housed at a central community site, such as a public library, youth center, or church. The site facilitates hands-on science activities, and includes large tabletops, work space, sinks, uncarpeted floors, comfortable seating, and adjustable lights and temperature. Program staff accumulates a wide array of science equipment and supplies and stores them in a locked area at the site. The model allows for occasional visits to the university during the school year to conduct some science activities. Occasional field trips to community sites during the school year expose students to a range of locations for seeing and doing science.

Target Population and Recruitment/Selection

Model #1 recruits minority, predominately Black, rising-sixth grade students. Though the program seeks minority students, all students are encouraged to apply. These students represent various levels of ability and interest in science, and attend local middle schools. Special attention to minority male and female proportions ensures fair access to the intervention. Model #1, free of cost to participants, aims to achieve a participant to instructor ratio ranging from 6:1 to 8:1.

To encourage participation, the program offers one-hour recruiting sessions at area middle schools, churches, youth centers, public libraries, and other popular spots throughout the local area. These sessions use hands-on science activities, demonstrations, attractive handouts, and dynamic presentations to entice students and their families to participate. Supplemental recruiting strategies include mailing letters to parents and setting up booths at local shopping centers and grocery stores.

Intervention Activities

Because Model #1 is a university-wide science intervention program, the intervention activities involve various units (i.e., colleges, departments, and centers) across the campus. During the summer component, guest speakers, field trips, and hands-on activities related to current local research in the medical and veterinary schools, as well as in the entomology/nematology, earth sciences, ecology, chemistry, physics, and agriculture departments, introduce students to each area of expertise. The activities emphasize science process skills, science content knowledge, attitudes toward science, and science-related careers. Attention to the requirements for university admissions and how middle school students can begin to prepare (i.e., by considering the implications of high school coursework selection and study habits.) for future academic endeavors supplements the exposure to possible career paths. The school-year component includes weekly activities on Saturdays. These activities include hands-on science activities, mentoring, field trips, career explorations, biographical studies, and other motivational experiences to maintain the students' interest. Additionally, monitoring students' progress in school holds them accountable for their achievement. Ideally, Model #1 participants remain in the program throughout their middle school matriculation.

Program Staff

The university's college of education administers the program, and is responsible for recruiting and selecting middle school participants. Graduate assistants from the college of education who represent the gender, race, ethnicity, and background of the participants work directly with the students as their residential advisors and school year mentors. The graduate assistants, who earn a competitive salary during the summer and a stipend during the school year, learn about the program during a one-week training workshop. In preparation for the science intervention activities, the education students work with the science faculty and graduate students to develop pedagogically sound, yet relevant hands-on activities. This also increases the levels of competence and comfort education majors have with science. The science faculty members create meaningful presentations and serve as role models and tour guides of applicable sites. The program calls for one week of participation per department. Hence, one summer component utilizes three departments. The science faculty earns honoraria large enough to share with their graduate students, should they make that choice.

As the program continues the following summer, six departments participate—three new departments for returning students and the three previous departments for new students. Student who remains with Model #1 for their entire middle school careers gain familiarity with nine science departments/fields. That number bears significance, considering the lack of science exposure and experiences noted by female and minority students in a number of research studies.

Discussion

Model #1 offers great benefits to its student participants. Kahle and Lakes (1983) report that by middle school, students' attitudes toward science are fixed. Although Steinkamp and Maehr (1984) note that both boys and girls experience declines in their positive views toward science during adolescence, the attitudes of boys manage to rise later, while those of girls do not. Hence, a program that targets girls in their early middle school years provides a supportive environment that can counter a potential attitudinal decrease. Additionally, Kahle and Lakes (1983), Anderson (1989), and Catsambis (1995) all found that girls and minorities fail to understand the applications or relevance of science. Girls and minorities also seem unaware of the variety of science-related careers. The Draw-A-Scientist test (Chambers, 1983) indicates that most students believe scientists are old, White men who wear glasses and work in a laboratory. Exposure to the variety of science disciplines noted above offers an opportunity to address that antiquated perception. Additionally, the emphasis on research based on local issues demonstrates to students the significance of university-level research on their everyday lives. Speaking with diverse, active researchers/faculty provides answers to the questions Model #1 participants undoubtedly pose—"Why is science important?" and "How does science affect me?" Female and minority students who participate in the program meet and talk with female and minority students in the departments that Model #1 visits. The relationships that develop, as well as the benefits of sheer observation, indicate that opportunities exist for people of all types.

Model #1 benefits the university community and faculty participants in several ways. During uncertain times of looming budget cuts and discussions of departmental consolidation, the more exposure each department receives, the greater the likelihood of attracting potential students. The outreach opportunity fosters an understanding of the relevance of each field to everyday life. As Kahle and Lakes (1983) explain, when students have positive experiences in science, they gain an understanding of the uses and applications of science. This nurtures a positive attitude, and may ultimately lead to a career in science. The public university, functioning as an educational agent for the state, develops a heartier relationship with the local community. The potential for each participating department to attract new students, educate the public, participate in local outreach, and become involved with cross-campus collaboration serve as remarkable incentives to be a part of Model #1.

The implementation of Model #1 varies with the resources of each university. This model serves as a template to be used when developing new science intervention programs and modifying existing programs.

Model #2

Model #2 targets multiple portions of the educational pipeline—elementary, high school, and university. Although girls and minorities from low performing elementary and high schools in a localized area are targeted, Model #2 can become a network of programs that spans a state or region. The local school district or university administers each program, but similar goals and an overarching infrastructure connects each Model #2 program. The program should serve the South Atlantic region of the U.S. because, as Clewell, Anderson, and Thorpe (1992b) reported, the majority of the existing science intervention programs are not located where the majority of the Black population resides.

Program Objectives

The objectives of Model #2 include emphases on science process skills, science content knowledge, attitudes toward science, and science-related careers. They incorporate cognitive (i.e., knowledge, understanding, inquiry, and processes), affective (i.e., attitudes, values, and habits of mind), psychomotor (i.e., physical skills), and social (i.e., communication and interaction) learning objectives. The well-rounded approach of Model #2 allows students to identify the relevance of science in their lives, as well as answer questions including: What are the skills of science? How can these skills be used in all aspects of my life? What science knowledge is important to know at my developmental level? How can my science literacy be used to make informed decisions everyday of my life? How do I feel about science? How do I feel about myself as a doer of science? What are my perceptions of science? And how can my science skills, knowledge, and attitudes be used to benefit society in the form of a career?

Model #2 articulates the program objectives to university staff members during a one-week pre-program training workshop. Additionally, discussions of the objectives occur in a program handbook and at bi-weekly meetings during the course of the program. Parents and participants learn of the objectives during recruiting sessions, orientation meetings, and via a parent/participant handbook.

To assess the achievement of the objectives, Model #2 uses surveys, pre- and post-tests, interviews, and performance measures. Program staff administer these measures at the end of each school year. This provides information regarding the effectiveness of that year and can serve as a formative evaluation tool. At the end of two years, an outside evaluator should conduct extensive reviews of the program, using a variety of quantitative and qualitative evaluation techniques. An external summative assessment can determine the impact of Model #2 on students who have remained with the program for two years.

Program Format

Model #2 uses its objectives to develop its format. The model, a year-round science intervention program, offers after-school and summer components and involves three types of participants: elementary students, high school students, and university students. University students enter the program during the summer, while high school students enter during the fall semester and continue through the following summer. The high school summer component offers a two-week residential experience. Elementary students' participation is limited to the school year in an after school format. These three groups of students participate in a layered intervention, where the university students service the high school students during the school year and summer, and the high school students service the elementary students during the school year. Model #2 strongly encourages high school and university students to participate throughout their matriculation.

Program Location

Portions of each component occur at the local elementary school or other after school site, at the local university, and at local community sites, such as businesses, factories, and other areas of commerce and industry. During the first summer component, Model #2 utilizes a university campus as its primary site. This is the location of the university students' six-week science methods/science resources course that prepares them for the intervention program. Additionally, it provides them with access to science and education facilities and equipment while preparing science activities. The university students also use local community resources to plan field trips, identify guest speakers, and arrange other relevant experiences for the high school students.

During the school year, Model #2 utilizes the university. Again, this provides the high school and university students access to science facilities and equipment. During the outreach experiences, Model #2 takes place at numerous local elementary schools or other after-school sites. The sites should facilitate hands-on science activities, and include large tabletops, workspace, sinks, uncarpeted floors, comfortable seating, and adjustable lights and temperature. The high school summer component uses the university as its primary site. The university offers the amenities of a residential program, as well as ready access to science facilities and equipment. In addition to the dormitories and cafeterias, students use laboratories, meeting rooms, and other university facilities.

Target Population and Recruitment/Selection

Model #2 targets three types of students, university, high school, and elementary. Kahle and Lakes (1983) and Oakes (1990) have found that by the time they enter middle school, students' attitudes toward science are fixed. Due to the importance of developing positive attitudes toward science in the early years of school, the majority of the participants in Model #2 will be elementary school students. The target population includes elementary students at low-performing or disadvantaged schools because they are more likely to have a high proportion of minority students (Kahlenberg, 2000) and less likely to have adequate resources with which to offer effective school-based science programs (AAAS, 1997). Model #2 does not recruit specific students at target schools, but instead seeks to include the entire school population. The model directly affects students who participate in the after-school or extended day programs at each elementary school. If no after-school program is available, or if the program is not widely used, other popular after school sites, such as youth centers, public libraries, or churches, can function as alternatives.

Local high school students serve as the next group of participants for Model #2. The demographic characteristics match those of the population of elementary students with whom they work. Model #2 recruits average and above-average performing high school students who may or may not be motivated to study science.

The local university supplies the third group of participants. Model #2 recruits undergraduate and graduate students from education and science fields to take advantage of the expertise offered by both professions. Ideally, the university students compose a heterogeneous group of females and minorities, similar to the elementary and high school students with whom they work, however, the inability to meet this standard should not impede any science intervention efforts.

Intervention Activities

The program coordinator for a particular district hires 10-15 university students, graduate and undergraduate, from both science and education departments. During a six-week summer course taught by the coordinator, the university students learn science pedagogy, expand their content knowledge, conduct a variety of science experiments and activities, and identify numerous resources for local science teaching and learning.

Under the tutelage of the program coordinator, the students work together to prepare their arsenal of relevant information.

Early in the fall semester, the university students begin to recruit local high school students to work with elementary students in an exciting, hands-on science setting. The university students tap resources such as youth job-training programs and other community programs to find high school recruits. If this is unsuccessful, the university students make themselves visible in the high schools. The promise of earning a paycheck, having a university mentor, and the opportunity to work with children lures the high school students to Model #2.

When each university student has recruited 6-8 high school students, the training process begins at the university. Training, facilitated by the university students, consists of the science and education majors sharing, finding, and learning a number of science activities that cover a wide range of science topics and pedagogical techniques with their high school students. While the university students may pair up for efficiency, each remains a major mentor to his six to eight mentees. Using personal experiences, science activity books, the Internet, and other resources, the university and high school students work together to develop interesting, relevant, and fun science activities to share with elementary students. The high school students' experiences in the community provide the context for the science activities. Local culture, landmarks, events, activities, issues, and people provide the means by which the science content is introduced. The university students assist the high school students in identifying the appropriate science content and activities to complement the community-based topics. This allows the science that is shared with the elementary students to be relevant, meaningful, and engaging. During the training process, field trips to various local resources and pertinent guest speakers provide additional enhancements to the high school students. After approximately two months of training (i.e., three days per week and occasional Saturdays for field trips), Model #2 university and high school participants are ready to visit the elementary students.

The Model #2 coordinator devises a schedule in which two groups of high school students (i.e., 8-12 high school students accompanied by 2 university students) travel to a different elementary school or other site every day for three times a week. Each of these visits occurs after school. The rotating scheduling allows each elementary school to receive as many visits as possible over the course of the school year. The university and high school students present their hands-on science activities to the elementary students in an engaging way that facilitates meaningful learning. Permanent fixtures in each visit include strong content knowledge, emphasis on science content skills, and pedagogical techniques, including questioning. While at the elementary schools, the high school students' main responsibility is presenting/sharing hands-on activities, while the university students primarily supervise and assist.

After the elementary school component, the high school students participate in a residential summer program designed to provide them with hands-on laboratory and problem-solving experiences with science. This two-week component also provides the high school students with exposure to a variety of science-related careers. This component occurs at the university, and grants the high school and university students with access to a fully equipped science laboratory. The program coordinator purchases additional materials and supplies. The university students facilitate this program, thus maintaining their mentor/role model relationship with the high school students. Ideally, Model #2 participants continue their involvement throughout their remaining years in high school and at the university, respectively.

Program Staff

An assistant, associate, or full professor of science education serves as the program coordinator for Model #2. The coordinator hires 10-15 university students, graduate and undergraduate, from both science and education departments. The gender, race, ethnicity, and background of the students represent the demographics of the local area. These students earn a combination of course credit, a tuition waiver, and a competitive stipend for their participation in two summers and one school year. A six-week summer course prepares the students to begin working with Model #2, and frequent meetings remind them of the objectives and policies of the program. Each university student hires six to eight high school students who represent the demographics of the local area. The high school students earn minimum wage, and this cost may be offset if a youth job-training program sponsors the high school students.

Discussion

The arrangement of Model #2 benefits all groups of students involved. Elementary students, who may otherwise have limited exposure to science and its applications, gain first-hand experiences. Through the use of hands-on activities and meaningful questions, they acquire useful knowledge and skills. Additionally, this process occurs on the students' own terms. In contrast to Haberman's (1991) pedagogy of poverty, Model #2 allows students to take responsibility for their own learning. They do not behave as mere receptacles of knowledge, but instead participate in a non-threatening endeavor. Model #2 facilitates this through the use of locally based engaging activities, a variety of questions, and positive relationships among the participants. Students do not behave as they do in a passive classroom, or expect the same interactions to be present in an after-school setting. Elementary students do not earn grades for participation, but rather they enjoy and choose to participate. The mode in which the high school students present the activities and information is comfortable to them and their elementary counterparts. Parsons' (2000) notion of culturalizing science instruction and Monhardt's (2000) insistence that cultural incongruity results in problems in education support this arrangement. Because both the high school and elementary students come from the same neighborhoods, attend the same churches, know the same people, and confront the similar local issues, a connection links these two groups of students. A level of cultural congruity exists between the high school and elementary school students that likely does not exist between either group of students and their science teachers. The extrapolation of this cultural congruity to relevant experiences gives science the perception of being accessible and not for the culturally elite. Hence, the incorporation of positive experiences and influences affects the attitudes, knowledge, and skills of the participants. The high school students benefit from the mentor-mentee relationship they have with both the university students and the elementary students. Their views of science and themselves become more positive, and may improve their achievement in science. Additionally, through the university students, discussions, presentations, and field trips, the high school students are exposed to careers in science and science education.

The university students benefit from Model #2 because they develop caring relationships with youth. The shared science and pedagogical knowledge motivates science majors to learn how to educate effectively in the fields of science, and encourages education majors to incorporate science into their teaching. This aims to achieve the ultimate goal of affecting generations of currently underrepresented minority and female science students.

The implementation of Model #2 varies with the resources of each university. This model serves as a template to be used when developing new science intervention programs and modifying existing programs.

Conclusion

Clewell, Anderson, and Thorpe (1992a) identified five key components of science intervention programs—goals, design, content, context, and outcomes. Goals refer to program objectives, while design focuses on format, location, and recruitment/selection. Content emphasizes program staff and intervention activities. Program design and content interact to produce the desired participant-related outcomes. These outcomes can include students' attitudes, performance and achievement, course taking, and career choice. The context considers elements that exist outside of the program, yet still affect the program, such as funding opportunities, the need for the program, and collaborative relationships with the local community and institutions. This study focused on the components of goals, design, content, and context. Due to the variation in intervention programs and the focus of this study on descriptive patterns and evaluative meanings, program outcomes were not investigated.

Model #1 was informed by elements of MidCom, SumSpace, and Enviroyear (see Appendix G). While only one facet each of content (i.e., education-trained staff) and context (i.e., community sites as field trips) were influential, several facets of design affected the model. Likewise, regarding the influence of the cluster programs on Model #2 (see Appendix H), one facet of content (i.e., education-trained staff) and seven facets of design were significant. This suggests the non-prescriptive nature of these models. As program objectives lead to program design, program design focuses on structural components that can be tailored to meet the particular needs and resources of the program. Format, location, and recruitment/selection (i.e., design) provide a foundation that can be adjusted given the content, context, and desired outcomes. In this manner, the two models serve as adaptable templates for science intervention programs for Black students.

Although many other potential models exist, the two models described above effectively address the weaknesses identified in this study's cluster evaluation. Science intervention programs can be structured in a number of ways. The two models represent only two approaches to science intervention programs. Each of these models tackles the issue of science intervention in unique ways, and can be modified according to the availability of resources. While Model #1 provides science intervention for middle school students, Model #2 involves elementary, high school, and university students. A university that incorporates both models has the opportunity to greatly impact the local community. Nearly all aspects of the educational pipeline can be served, thus providing numerous opportunities for Black students to study science.

CHAPTER 7
CONCLUSION

The purpose of the study was to investigate the underlying meanings of existing, publicly administered science intervention programs for elementary through high school Southern Black students. The study utilized a modified cluster evaluation approach to examine science intervention programs in South Carolina, Georgia, Maryland, and the District of Columbia, the areas with the highest proportions of Blacks in their populations. Five science intervention programs, representing four public universities and three states, comprised the sample. Data collected from print materials, site visits, questionnaires, and interviews were used to identify implicit patterns that illustrated the nature of efforts to achieve the goal of Project 2061—science for all. The study used empirical research and the strengths and weaknesses of existing programs to develop two models for new and/or modified science intervention programs.

The study answered three research questions: (a) What science intervention programs do Southern state universities offer Black elementary through high school students in an effort to make science for all? (b) What does a cluster evaluation of existing science intervention program reveal about their intent and efforts? and (c) How can existing programs inform the development of a model for science intervention programs for Black students?

Of the 15 science intervention programs that met the criteria to be included in the study, five agreed to participate. To answer the first research question, data were collected regarding each program's objectives, format, locations, target population, recruitment and selection strategies, intervention activities, staff, and financial information. The data sources included print materials, Program Coordinator Questionnaires, observations during site visits, and interviews with program participants and staff. As the characteristics of each program emerged, they were recorded in a matrix that allowed for cross-comparison of the programs.

The second research question was answered by first outlining the minimum and ideal standards for science intervention programs for Black students. These researcher-developed standards consisted of attributes that science intervention programs should bear. The programs were not evaluated individually, but rather were evaluated as a cluster of programs with a similar overarching goal—to increase the participation of Blacks in science. The cluster of existing programs was reviewed to determine its ability to achieve the minimum and ideal standards. An evaluation of the cluster emerged from the review. The cluster evaluation identified numerous strengths and accomplishments in the five science intervention programs, but also revealed gaps in emphasis, insufficient use of community sites, and meager intervention activities for younger students.

The results of the cluster evaluation, in addition to empirical research and the researcher's knowledge of other relevant programs, informed the development of two models for science intervention. The models addressed the third research question. Each of the models contained a discussion of the program's objectives, format, location, target population, recruitment and selection strategies, intervention activities, staff, and financial information.

Discussion

The study found that science intervention programs for Black students do exist in the South. These programs aim to achieve a wide range of objectives through a variety of means. Though these programs offer valuable opportunities for participants and staff, they could benefit from improvement in three key areas: (a) increasing their emphasis on science process skills and science-related careers, (b) improving the use of community sites for doing and seeing science, and (c) expanding intervention efforts to include elementary students.

The notion that knowledge is power (Sleeter & Grant, 1991) can be extrapolated to include science as knowledge, and thus science knowledge as power. Baptiste (1989) maintains that the social distribution of science knowledge in the United States results in White males with access to power and its benefits, while minorities and females remain powerless and subject to oppression. The findings indicate that the cluster's good intentions do not suffice in the effort to counter the past ills of science. The cluster maintains its own social distribution of science knowledge that excludes local communities and young students, without focusing on career-oriented applications of science.

In recent decades, U.S. society's acknowledgement of unequal science participation among men and women and minorities and Whites has resulted in efforts to decrease these disparities. Through science intervention programs, society aims to make science for all by the year 2061 (Rutherford & Ahlgren, 1990). This need for science intervention stems from several rationales: (a) to maintain and increase the industriousness and economic strength of the country (Johnson, 1992; Miller, 1995); (b) to participate in areas such as healthcare, biomedical research, and environmental issues that will benefit underrepresented groups (Johnson, 1992; Miller, 1995), while maintaining Dewey's (1944) image of a participatory democracy, and (c) to provide equitable science opportunities for minority and female students (Atwater, 2000). Miller (1995) explained the ability to increase the nation's industriousness and economic strength as a balance between the educated elite, who advance knowledge, and the well-educated general population, who apply knowledge.

The programs evaluated in this cluster emphasized attitudes toward science and science content knowledge. Highlighting these areas encouraged students to value science, while learning relevant content. Though important, this occurred at the expense of science process skills and science-related careers, which were underemphasized. The cluster prepared students to apply knowledge, rather than advance knowledge. Thus the cluster added to the general population, not the educated elite. The need to highlight science process skills, including designing and conducting experiments, was underscored by the insufficient focus on science-related careers that rely on the use of science process skills. This exposed the underlying consequence of the cluster—the good intentions of the programs did little to produce members of the educated elite.

As Miller (1995) explained, the educated elite possesses the expertise and knowledge to create, modify, and discover scientific and technological advancements. The general population, on the other hand, applies the advancements to daily life. Even the labels attributed to each group identify their relative status. The honored reputation of the advancers bears a greater value than that of the appliers. As Black students participate in existing science intervention programs, they may become relegated to the status of the general population and fail to gain entry to the educated elite. This serves to perpetuate the status quo, rather than eliciting lasting, systemic changes.

Clewell, Anderson, and Thorpe (1992a) identified 163 science, math, and technology intervention programs for minorities and females. Their study, the only relevant comprehensive study to date, identified the South as the region with the fewest science intervention programs. An acknowledgement of the high population of Blacks in the South may lead one to realize that the location of most science intervention programs prevents the involvement of most Black students in the country.

The cluster of science intervention programs administered by public universities in the South demonstrated a level of efforts currently underway to reverse this situation. The cluster represented five programs in Maryland and various regions in South Carolina and Georgia. Coincidentally, the populations of South Carolina and Georgia are comprised of 29.5% and 28.7% Blacks, respectively (U.S. Census Bureau, 2001). Washington, D.C. (60%) and Maryland (27.9%) contain large proportions of Blacks, as well. Though Washington, D.C. contains more Blacks than the other states in the cluster, it contains only one publicly funded university. The close proximity of Maryland allows some of Maryland's universities to serve students in the District. Thus the burden of science intervention in Washington, D.C. does not fall on one institution.

Of the 46 science intervention programs offered by the 42 publicly funded universities in South Carolina, Georgia, Maryland, and the District of Columbia, 15 met the criteria for the study. After discounting the limitations of the criteria, only 33% of the identified intervention programs in the South targeted minority or Black students. Given that the South Atlantic sub-region contains the highest proportion of Blacks (U.S. Census Bureau, 2001), it stands to reason that to positively affect the Black population, more than one-third of science intervention programs in that region should target Blacks or minorities. This disparity unveils the continued shortage of intervention programs for Black students, especially in areas with a high Black population.

Fenske et al. (1997) discussed the surge in intervention programs designed to ease the elementary-secondary-post-secondary gap for disadvantaged and underrepresented students. These intervention programs use funds from a variety of sources to develop seamless transitions from elementary to secondary to post-secondary education. School-college collaborations subscribe to the K-16 model that demands systemic changes as schools and universities work together to address issues of educational accountability (Fenske et al., 1997).

In this study, the cluster utilized the K-16 model, and benefited both the students and the universities. The students gained educational opportunities and experiences, while the institutions created a system to recruit and prepare potential matriculants. Additionally, the intervention programs satisfied a core quality of each university's mission—to provide service to the local area and/or state.

The findings highlighted the strengths of the cluster, as well as their constraints in providing comprehensive science experiences for Black students. The two models, informed by the investigation of science intervention programs and empirical evidence, can serve as templates to be used when modifying and creating new programs, thus potentially improving the overall quality of science intervention programs targeting Black students.

Limitations of the Study

Several limitations must be considered when interpreting the results of this study. The study called for continuous programs, including programs that offered year-round intervention, school-year intervention, and/or summer programs of at least two weeks.

Programs such as competitions, fairs, guest speakers, special days, field trips, and one-week summer programs did not meet the criteria of the study. This may have contributed to the apparent dearth of science intervention programs in the South.

The study examined programs that claimed to target minority or Black students. Programs that did not specify a target group or that specified another target group, but served primarily Black students were not included. Additionally, programs that served primarily Black students, but based their target group on factors other than race or ethnicity, were disqualified. Again, this limitation may have decreased the number of eligible programs.

The study investigated programs administered by public universities. Excluded programs were those managed by centers, school districts, schools, and private institutions, as well as community colleges, four-year colleges, and professional schools that were not part of the state university system. The efforts of these institutions were overlooked, and may have affected the portrayal of science intervention. This limitation, while decreasing the number of eligible programs, also delegated the burden of science intervention to public universities.

The science intervention programs were identified primarily via Internet searches. Programs with no web site or that were not acknowledged on a university web site were not included in the study. These programs were unknown to the researcher, and their exclusion may have reduced the sample pool for the study.

The quantity and quality of information available to the researcher also served as a limitation. While some program coordinators responded to the questionnaire with thorough answers and supplemental materials, others provided only the bare minimum.

Likewise, some coordinators made themselves available for further questions via electronic mail and telephone calls, but others did not. The quantity and quality of information on the university web sites varied, thus limiting the research.

For various reasons, the number of site visits was limited. In one case, the program was not operating during the data collection phase of the study. Another program was phased out during the data collection phase. A third program could not be visited because the program coordinator did not complete the required paperwork. Thus, the inability of the study to report site visit and interview data for all programs in the cluster served as a limitation.

While not necessarily a limitation, the exploratory nature of this study prevents generalization. This study investigates science intervention programs for Southern Blacks as represented by the five programs in the cluster. Additional research is required to corroborate the findings of this study, particularly as they pertain to other science intervention programs and the larger initiative, science for all.

Implications

The public generally assumes the effectiveness of science intervention programs for minorities while educational researchers, theorists, and practitioners debate the existence of equitable experiences for students. This study makes four major contributions to the debate, and each has implications. Three of the contributions stem from the three research questions, while one arises from the research design. The study (a) identifies and describes several science intervention programs for Black students, (b) uses a modified cluster evaluation to formatively evaluate the South's effort to make science for all, (c) provides a set of minimum and ideal standards for science intervention programs for Black students, and (d) shares two research-based models that meet the standards and address the weaknesses of existing programs. The implications of each of these contributions will be described below.

Identification and Description

Science intervention programs for Black students remain a major component of efforts to make science for all, but very little comprehensive research has been conducted. Most research about science intervention programs reveals insight about specific programs or the efforts of a particular institution. This study offers a portrayal of science intervention in the South, which provides one level of wide-ranging research. In addition to identifying a number of science intervention programs, this study describes their key characteristics. This contribution, as valuable as it is unique, provides key data to funding agencies, program coordinators, and individuals and institutions with a desire to engage in science intervention.

The data can be used to ascertain areas of service gaps and/or overlap, and to compare and contrast the various designs of existing programs. This study can be used to distinguish well-served students and local areas from those that are underserved. As a result, funding agencies can isolate new target groups and geographical locations to sponsor or encourage. Consequently, existing and potential coordinators can design programs to serve new students and local areas, thus closing current gaps in service. Other service gaps relate to program emphases, as represented by the program objectives. This study reports specific program objectives, and classifies them into four categories (i.e., science process skills, science content knowledge, attitudes toward science, and science-related careers). This information can be used to develop new programs that address underemphasized categories, thus closing current gaps in service.

The descriptions of each program contain data on eight key components of science intervention programs (i.e., objectives, format, location, target population, recruitment/selection, intervention activities, staff, and financial information). These thorough descriptions can serve as the foundation for further research on the identification and/or effectiveness of science intervention programs, and the development of a relevant database. Further research, including development of a database of science intervention programs can benefit the educational community, students, parents, funding agencies, and the overall effort to make science for all. The benefits can result from increased awareness of existing programs and thorough comparisons of the programs' key components. As such, this study can serve as a catalyst for comprehensive research on science intervention programs for Southern Blacks.

Cluster Evaluation

The national initiative to make science for all should come to fruition by the year 2061, and this study offers a formative view of the South's effort to comply. As funding agencies and government entities dole out monies to create programs and services to make science for all, they require formative and summative evaluations of those endeavors. To date, no individual or organization has attempted to evaluate the progress of the overall initiative as it relates to science intervention for Black students. This study, however, makes such an attempt.

Using a modified cluster approach, this study evaluates science intervention for Black students in the South. This contribution undergirds current conversations on science intervention, science education, and educational equity because it considers underlying patterns and meanings. Hence, efforts to make science for all in the South may imply different meanings and result in different manifestations than comparable efforts in other regions of the United States. Because this study judges existing attempts as an aggregate, rather than individually, it can inform parties interested in systemic changes. Those parties can use the evaluation results to determine areas of strength and weakness in science intervention programs for Black students, as represented by the cluster. Thus, the evaluation offers one interpretation of the effectiveness of science intervention programs in the South.

Cluster evaluation, a developing but still narrowly used evaluation approach, lacks sufficient research and application to perpetuate its growth. Though employing a modified use of cluster evaluation, this study demonstrates the novel application of the methodology. For evaluation experts, this can contribute to the development of cluster evaluation as a bona fide approach.

Standards for Science Intervention

While some science intervention programs may be based on research, most are developed from educated intuition. Some previous research has identified effective characteristics of science intervention programs, but none has named and described a set of standards to be implemented. This study provides that much-needed framework for science intervention programs.

The standards consider eight components of science intervention programs (i.e., objectives, format, location, target population, recruitment/selection, intervention activities, staff, and financial information), and explain how each component should be addressed in minimum and ideal situations. The specificity of the standards can facilitate structured program evaluation, even with varying program designs. Due to the previous lack of standards, existing programs evaluate their effectiveness on self-determined criteria. While this serves a purpose, no standards exist for norm-referenced evaluation, until now. As these standards become widely implemented, funding agencies, government entities, and educational researchers will have a means of comparing programs to each other. During this era of standards-based accountability this study offers a valuable tool for program evaluation.

Program developers can use the standards described in this study to improve existing programs and to create new programs. The two levels of standards, minimum and ideal, allow program developers to consider available resources, as well as the needs and personalities of their target population and local area. Though explicit, the standards do not prescribe program designs. They do, however, describe key components that should be implemented in accordance with program design.

Two Models

The cluster evaluation included in this study resulted in a description of the strengths of science intervention in the South, as well as some areas of improvement. To assist in the improvement process, the study presents two models of science intervention programs. These models, different in design and implementation, address the perceived weaknesses of the cluster. The models represent the collaboration of empirical research, relevant literature, the standards included in this study, personal experience with science intervention, and the investigated cluster of programs.

The existence of the models offers practical means to address the theoretical issues contained in the study. Rather than merely identifying the shortcomings of science intervention programs, the study presents two templates to attend to those limitations. This bears importance when considering the historical quarrel between educational theorists and practitioners. The study moves beyond the description and criticism common to theorists and into the realm of viable change for practitioners. As many program coordinators likely spend little time researching theory and criticism, the inclusion of concrete suggestions (i.e., two models for science intervention programs) can offer meaningful assistance during program development.

Recommendations

As previously mentioned, a database identifying science intervention programs can benefit the research community, as well as parents and students. This study provides the groundwork for beginning such a database. The database can be organized by: target population, geographic location, program format, funding source, or type of administering institution. This resource can provide the foundation for further research on science intervention programs.

The results of the study demonstrate that existing science intervention programs carry explicit benefits and implicit losses. These benefits and losses can be elucidated by further research. Additional studies on science intervention programs for Southern Black students should consider more programs than this study allowed. Perhaps the selection criteria should be broadened to include programs administered by institutions other than public universities. The current emphasis on socioeconomic status, rather than race/ethnicity suggests that future research should take into account this changing tide of intervention efforts.

A similar study should be conducted with an incentive for program coordinators to become involved. This will increase the sample size and provide a far-reaching picture of science intervention in the South. This picture can be further illuminated via a series of cluster evaluations conducted in a number of states, sub-regions, or regions. The results of this study indicate that further research can be used to evaluate science intervention efforts that include females, Hispanic Americans, Native Americans, and other underrepresented groups.

Because this study highlights the efforts to improve science participation by the year 2061, additional research should be accomplished with the same deadline in mind. Evaluations of Project 2061 should be conducted periodically to assess its progress and to suggest areas of improvement. Further research will reveal the successes and needs of the initiative to make science for all. This study provides the groundwork for additional research that may ultimately affect the appropriation of government and private funds, the development of future science intervention efforts, and the ability of the nation to achieve the goal of Project 2061—science literacy for all.

APPENDIX A
STUDY DESIGN MATRIX

	Phase 1 Description & Interpretation	Phase 2 Evaluation	Phase 3 Model Formation
Research Question	What intervention programs do Southern public universities offer in an effort to make science for all?	What does a critical analysis of existing intervention programs reveal about their intent and efforts?	How can existing programs inform the development of a model for science intervention programs for Black students?
Data Sources	Print artifacts (web pages, brochures, newspaper/magazine/ journal articles, reports), questionnaires from program coordinators, communication with program coordinators, field notes, interview notes	Print artifacts, questionnaires, field notes, interview notes, personal communication, interpretations of data	Empirical evidence (strengths, weaknesses, suggestions for programs) from related research, literature reviews (how children learn science, how, Black students learn, intervention programs)
Data Collection Techniques	Web search, databases, & newspaper archives, telephone calls, email, mail, observations, semi-structured interviews	Research notebook/audio recorder to document interpretations, use collected data	Use collected data, library/database search
Data Analysis Techniques	Constant comparison (discovery, coding, discounting), triangulation of all data	Cluster evaluation	Synthesis of all data
Timeline	March 2002- December 2002	December 2002- January 2003	January 2003-February 2003

Note: Interpretation of data will be an ongoing process. The timeline merely indicates when the bulk of the interpretation will be completed. Additionally, writing the narrative will be an ongoing process.

APPENDIX B
42 PUBLIC UNIVERSITIES IN GEORGIA, MARYLAND, SOUTH CAROLINA, AND WASHINGTON, D.C.

Georgia

1. Albany State University (HBCU)
2. Armstrong Atlantic State University
3. Augusta State University
4. Clayton College & State University
5. Columbus State University
6. Fort Valley State University (HBCU)
7. Georgia Institute of Technology
8. Georgia State University
9. Georgia Southern University
10. Georgia Southeastern State University
11. Kennesaw State University
12. Savannah State University (HBCU)
13. North Georgia College & State University
14. Southern Polytechnic State University
15. State University of West Georgia
16. University of Georgia
17. Valdosta State University
18. Gwinnett University Center
19. Georgia College & State University

Maryland

20. Bowie State University (HBCU)
21. Coppin State University (HBCU)
22. Frostburg State University
23. Salisbury State University
24. Towson University
25. University of Baltimore
26. University of Maryland, Baltimore
27. University of Maryland at Baltimore County
28. University of Maryland at College Park
29. University of Maryland Eastern Shore (HBCU)
30. Morgan State University (HBCU)

South Carolina

31. The Citadel
32. Clemson University
33. Coastal Carolina University
34. Francis Marion University
35. Lander University
36. Medical University of South Carolina
37. South Carolina State University (HBCU)
38. University of South Carolina-Aiken
39. University of South Carolina-Spartanburg
40. University of South Carolina-Columbia
41. Winthrop University

Washington, D.C.

42. University of the District of Columbia (HBCU)

<u>Note</u>: HBCU denotes Historically Black Colleges and Universities

APPENDIX C
PROGRAM COORDINATOR QUESTIONNAIRE (PCQ)

PROGRAM NAME:

UNIVERSITY:

1. What are your program's objectives?
2. How have these objectives been articulated to your staff?
3. How have these objectives been articulated to your participants?
4. How are the program objectives measured?
5. How often does your program meet?
6. How long does the program meet during each contact?
7. In what types of activities are your participants engaged?
8. Describe the students your program targets (gender, ability level, race/ethnicity, local community).
9. Describe the students your program actually serves (gender, ability level, race/ethnicity, local community).
10. How are participants recruited to your program?
11. How are participants selected?
12. Do participants have an opportunity to participate next year/session?
13. Where do the program activities occur?
14. How do the demographics of your staff (race/ethnicity, gender) compare to that of your participants?
15. Do staff members have an opportunity to participate next year/session?
16. How are staff members trained?
17. How are staff members compensated?

APPENDIX D
DATA ANALYSIS TOOL

Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Program Objectives					
Should emphasize at least two of SKAC (ideally, all)					
Should be articulated to staff during pre-program training (ideally, reiterated during program at regular meetings)					
Should be articulated to participants/parents via pre-program session, letter, or handbook (ideally, parents come to recruiting session)					
Should be measurable and measured by an internal evaluator via traditional methods (ideally, also external evaluator with alternative methods)					
Program Format					
Daily meetings for concentrated sessions, weekly meetings for yearlong sessions (ideal)					
Students should be able to participate next year (ideally, continue throughout schooling)					
Program Location					
Primary location should be at a community site or neighborhood school with university facilities as supplement (ideally, occur in and relate to community site)					
Programs not in community should take field trips or conduct projects/activities within community at least 2X (ideally, all program use community sites for majority of projects and field trips)					
Programs should foster hands-on activities, including access to science equipment and supplies (ideally, fully-equipped laboratory)					

Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Target Population & Recruitment/Selection					
Participants should represent a range of ability levels					
Participants should not be excluded on the basis of fees; program should be free or aid be readily available (ideally, programs should be free)					
Participants should be actively recruited, not just their parents (ideally, families should be recruited)					
Programs should serve a variety of neighborhoods, communities, and schools, unless a special neighborhood, community, or school is the target group					
Intervention Activities					
Activities and program format should be consistent with the objectives					
Hands-on, traditional, group work, and individual activities should be offered (ideally, in comparable proportions)					
Programs should offer 3 hands-on activities for concentrated components or 1 for year-long; programs should offer 1 design project for concentrated or year-long programs					
Programs should offer mentors (same generation) in the form of diverse staff who are present at every session					
Role models should be diverse guest speakers, staff, or biographical studies at least 2x for concentrated sessions and once every 3 meetings for year long (ideally, role models present at all sessions)					
Programs should emphasize science-related careers via field trips, guest speakers, biographical studies, and discussions (ideally, less common and more common careers should be emphasized)					

Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Staff Information					
Staff should be able to continue their participation next year (ideally, staff should continue their participation throughout the group's participation)					
Staff should be trained in a 4-hour workshop or seminar before the program (ideally, pre-program training should be 1-3 days)					
Staff should be offered financial or academic compensation					

APPENDIX E
SCIENCE INTERVENTION PROGRAMS ADMINISTERED BY PUBLIC UNIVERSITIES IN SOUTH CAROLINA, GEORGIA, MARYLAND, AND WASHINGTON, D.C.

South Carolina

1. Space Science Academy – South Carolina State University

2. Adventures in Science – University of South Carolina-Columbia

3. Summer Science, Engineering, and Architecture Enrichment Program for Rising 7-12th Graders – Clemson University

4. Teaching Kids About the Environment (KATE) – Clemson University

5. Camp Tech Quest/Camp SeeWee – Clemson University

6. Camp Wildlife – Clemson University

7. Explore the IPM House – Clemson University

8. Landscapes for Learning – Clemson University

9. Project Youth and Environmental Studies (YES)/GEAR-UP – Lander University

Georgia

10. Summer Camps at the Aquarium – University of Georgia

11. PREP – North Georgia College & State University

12. Summer Prep-it Up – Kennesaw State University

13. Elementary School Experience – Kennesaw State University

14. Eagle Science Residence Camp – Georgia Southern University

15. Volunteer Training Camp – Georgia Southern University

16. Partners in Education Summer Exploratory Program – Augusta State University

17. Middle Grades Students and Teachers Educational Partners Academy – Augusta State University

18. Kids University – Augusta State University

19. Project Success – Augusta State University

20. Saturday Science – Southern Polytechnic State University

21. Georgia Youth Science and Technology Centers, Inc. – Southern Polytechnic State University

22. CARES Camps – Columbus State University

23. PRIME Camp – Columbus State University

24. Prep PRIME – Columbus State University

25. SMART Camp – Columbus State University

26. Power Camp – Columbus State University

27. GEAR-UP – Savannah State University

28. SummerScape – Georgia Institute of Technology

29. Career Awareness in Science and Engineering – Georgia Institute of Technology

30. SECME – Georgia Institute of Technology

31. PREP – Georgia Institute of Technology

32. MITE – Georgia Institute of Technology

Maryland

33. NASA/Center for Math, Science, and Technology – University of Maryland Eastern Shore

34. Academy for Applied Science and Mathematics – Towson University

35. $E=mc^2$ – University of Maryland at College Park

36. Upward Bound Math/Science Regional Center – University of Maryland at College Park

37. 10^{th} Grade Girls Summer Program – University of Maryland at College Park

38. Hands-on Minds-on: Science, Mathematics, Reading, and Writing – University of Maryland at College Park

39. Upward Bound Regional Math/Science Center – Frostburg State University

40. Saturday Academy – Morgan State University

41. Project PRIME – Morgan State University

42. Academic Champions of Excellence – Morgan State University

43. Baltimore Ecosystem Study – University of Maryland at Baltimore County

44. New funding, program yet to be administered – University of Maryland at Baltimore County

Washington, D.C.

43. Project Camps 2 – University of DC

44. Science, Engineering, Mathematics, and Aerospace Academy – University of DC

APPENDIX F
COMPLETED DATA ANALYSIS TOOL

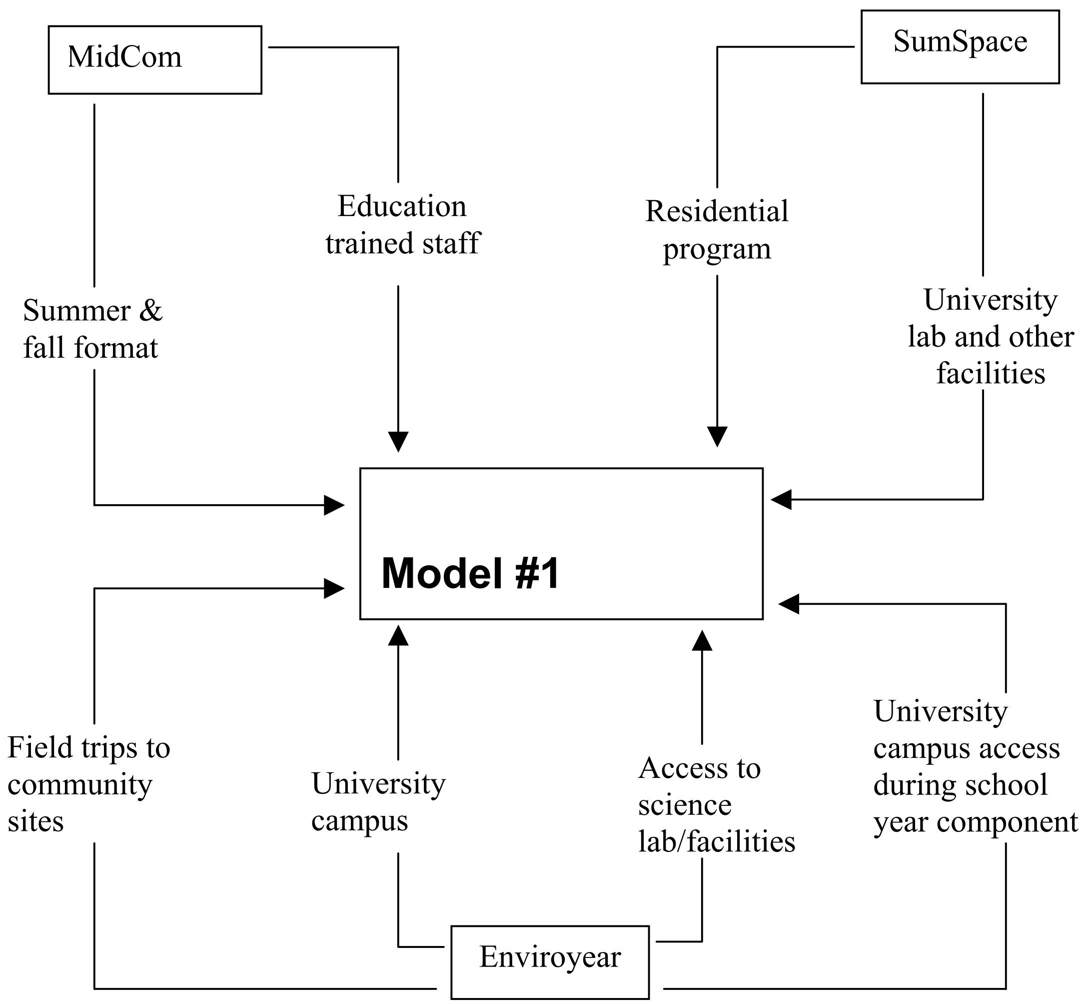
Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Program Objectives					
Should emphasize at least two of SKAC (ideally, all)	X	X	X-	X+	X
Should be articulated to staff during pre-program training (ideally, reiterated during program at regular meetings)	X	X+	X+	X	X+
Should be articulated to participants/parents via pre-program session, letter, or handbook (ideally, parents come to recruiting session)	X	X	X	X	X+
Should be measurable and measured by an internal evaluator via traditional methods (ideally, also external evaluator with alternative methods)	X	X	X	X -	X
Program Format					
Daily meetings for concentrated sessions, weekly meetings for yearlong sessions (ideal)	X+	X+	X+	X+	X+
Students should be able to participate next year (ideally, continue throughout schooling)	X+	X-	X	Not clear, not likely	X+
Program Location					
Primary location should be at a community site or neighborhood school with university facilities as supplement (ideally, occur in and relate to community site)	X	X	X-	X-	X-
Programs not in community should take field trips or conduct projects/activities within community at least 2X (ideally, all program use community sites for majority of projects and field trips)	N/A	N/A	X	X-	X-
Programs should foster hands-on activities, including access to science equipment and supplies (ideally, fully-equipped laboratory)	X+, X+ X-, X- (4 sites)	X-	X+	X+	X

Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Target Population & Recruitment/Selection					
Participants should represent a range of ability levels	X+	X+	X+	Not clear	X+
Participants should represent target group, but not be excluded on the basis of race/ethnicity	X	X-	X	X	X
Programs should serve a variety of neighborhoods, communities, and schools, unless a special neighborhood, community, or school is the target group	X	X	X	X	X
Participants should not be excluded on the basis of fees; program should be free or aid be readily available (ideally, programs should be free)	X+	X	X+	X	X+
Participants should be actively recruited, not just their parents (ideally, families should be recruited)	Not clear	Not clear	X	Not clear	Not clear
Intervention Activities					
Activities and program format should be consistent with the objectives	X	X-	X	X	X
Hands-on, traditional, group work, and individual activities should be offered (ideally, in comparable proportions)	X	X	X+	X	X
Programs should offer 3 hands-on activities for concentrated components or 1 for year-long; programs should offer 1 design project for concentrated or year-long programs	X	X	X	X	X
Programs should offer mentors (same generation) in the form of diverse staff who are present at every session	X-	X-	X	X	X
Role models should be diverse guest speakers, staff, or biographical studies at least 2x for concentrated sessions and once every 3 meetings for year long (ideally, role models present at all sessions)	X	Not clear	X+	X	Not clear
Programs should emphasize science-related careers via field trips, guest speakers, biographical studies, and discussions (ideally, less common and more common careers should be emphasized)	X	X-	X	X	N/A

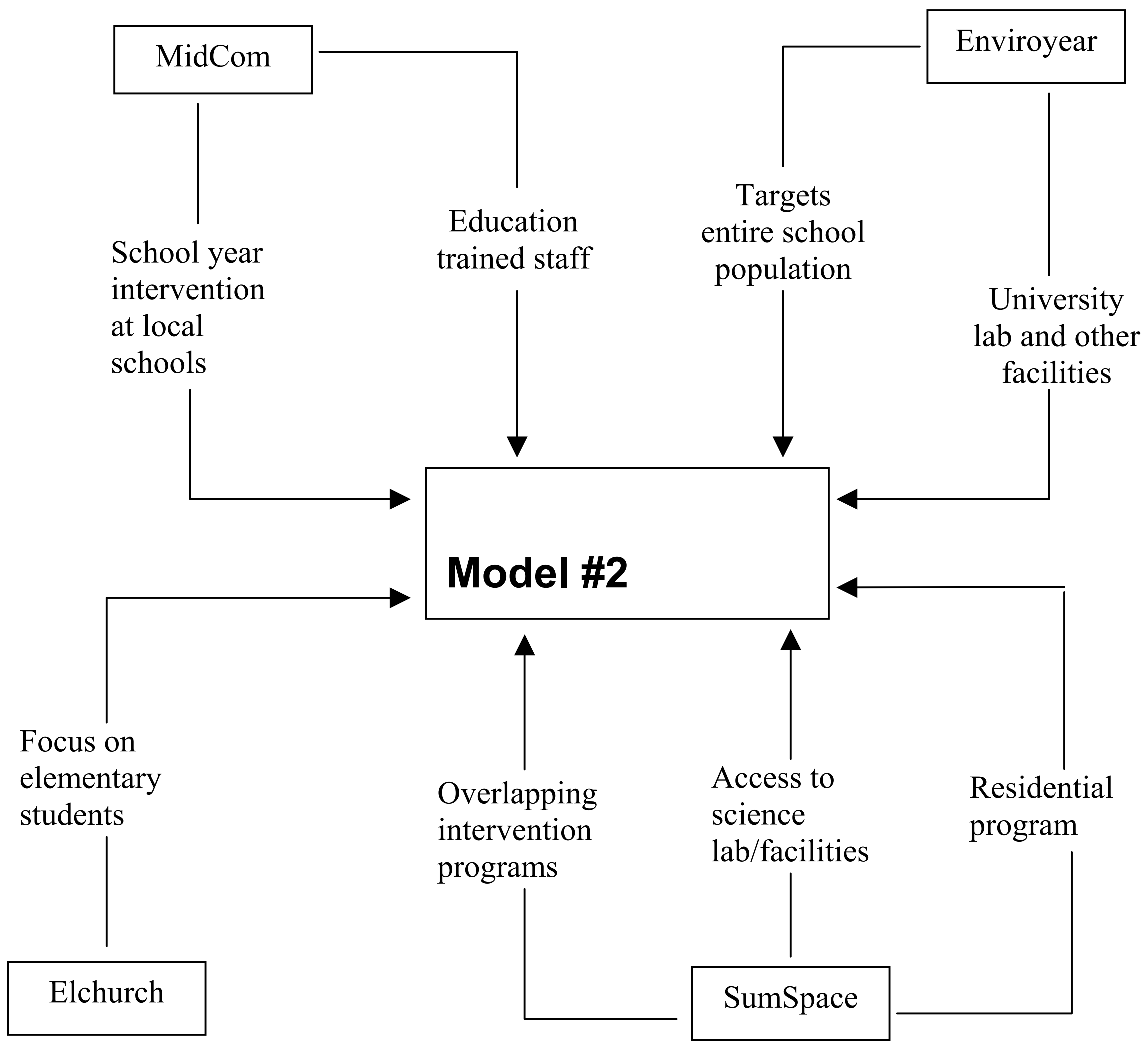
Standards	MidCom	Elchurch	Enviroyear	SumSpace	SpringSat
Staff Information					
Staff should be able to continue their participation next year (ideally, staff should continue their participation throughout the group's participation)	X+	X	X	Not clear	X
Staff should be trained in a 4-hour workshop or seminar before the program (ideally, pre-program training should be 1-3 days)	Not clear	X+	Not clear	X+	X+
Staff should be offered financial or academic compensation	X	X	X	X	X-

Note: X indicates the standard was met, X- indicates the standard was not met, X+ indicates the ideal was met.

APPENDIX G
INFLUENCE OF THE CLUSTER ON MODEL #1



APPENDIX H
INFLUENCE OF THE CLUSTER ON MODEL #2



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BIOGRAPHICAL SKETCH

Courtney Anne Johnson was born on April 13, 1975, in Brooklyn, New York, to Ronald and Linda Johnson. After living in New York for two years, she and her family, which consisted of Mom, Dad, and older brother Ronald, moved to Cleveland, Ohio. Courtney spent the next 12 years attending Shaker Heights public schools and experiencing the many wonders of the Cleveland area. In 1985, her family grew to include brother Carlos, a spirited two-year old. Courtney's family continued to expand when Dad married Rosemary, who had a son Othello. Siblings Sarah and Philip and stepfather Bert came several years later.

As a ninth grader, Courtney moved to Jacksonville, Florida, where she attended Kirby-Smith Middle School and Andrew Jackson Senior High School. She graduated from Jackson as class valedictorian in 1993 and earned a full scholarship to Florida Agricultural and Mechanical University (FAMU) in Tallahassee, Florida. Her plans to become a pediatrician changed after spending two summers conducting yeast research at the Uniformed Services University of the Health Sciences in Bethesda, Maryland. Instead, she intended to pursue a career as a research scientist. After earning a Bachelor of Science degree in biology in 1997, however, she began teaching science at Jefferson Davis Middle School in Jacksonville, Florida. That experience revealed to Courtney her true passion— education.

Realizing the need for formal education training, Courtney enrolled in the Proteach teacher education program at the University of Florida (UF). While in Proteach, Courtney's love for learning was inspired by her interest in after-school education. She was hired as the site coordinator for Project Learn at the Alachua County Boys and Girls Club-Southeast Unit where she coordinated educational activities for first through tenth graders. Immediately after earning a Master of Education degree in secondary science education in 1999, Courtney began her doctoral program in curriculum and instruction with a special emphasis on science education.

As a doctoral student in UF's College of Education, Courtney supervised secondary science interns and taught elementary science methods. Additionally, she served as an outreach coordinator for the Florida Museum of Natural History (FLMNH), where she worked with two after school science programs. That was a great experience for her, as Courtney's doctoral research focused on science intervention programs. In May 2003, Courtney earned her Doctor of Philosophy degree. She plans to continue working with and researching science intervention programs for African American students.