CHARACTERIZING THE LEARNING STYLES AND TESTING THE SCIENCE-RELATED ATTITUDES OF AFRICAN AMERICAN MIDDLE SCHOOL STUDENTS: IMPLICATIONS FOR THE UNDERREPRESENTATION OF AFRICAN AMERICANS IN THE SCIENCES

by

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ABSTRACT

CHARACTERIZING THE LEARNING STYLES AND TESTING THE SCIENCE-RELATED ATTITUDES OF AFRICAN AMERICAN MIDDLE SCHOOL STUDENTS: IMPLICATIONS FOR THE UNDERREPRESENTATION OF AFRICAN AMERICANS IN THE SCIENCES

Donald Ray Perine

African Americans, Hispanics, Native Americans and women are underrepresented among the population of scientists and science teachers in the United States. Specifically, the shortage of African Americans teaching math and science at all levels of the educational process and going into the many science-related fields is manifested throughout the entire educational and career structure of our society. This shortage exists when compared to the total population of African Americans in this country, the population of African American students, and to society's demand for more math and science teachers and professionals of all races.

One suggestion to address this problem is to update curricular and instructional programs to accommodate the learning styles of African Americans from elementary to graduate school. There is little in the published literature to help us understand the learning styles of African American middle school students and how they compare to African American adults who pursue science careers. There is also little published data

to help inform us about the relationship between learning styles of African American middle school students and their attitudes toward science.

The author used a learning styles inventory instrument to identify the learning style preferences of the African American students and adults. The preferences identified describe how African American students and African American adult science professionals prefer to function, learn, concentrate, and perform in their educational and work activities in the areas of: (a) immediate environment, (b) emotionality, (c) sociological needs, and (d) physical needs. The learning style preferences for the students and adults were not significantly different in key areas of preference.

A Test of Science-Related Attitudes (TOSRA) was used to measure seven distinct science-related attitudes of the middle school students. A comparison of the profile of the mean scores for the students in this study to a national norm, comprised of students of all races, showed no significant differences. The attitudes that African American middle school students have toward science are influenced by science professionals (role models), their parents, and their teachers. This correlates directly with the high preference for Parent Motivated and Teacher Motivated learning style preferences.

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CHAPTER 1

INTRODUCTION

The purpose of this research was to identify the learning styles of African American students, teachers, and professionals, as a way to better understand the problem of underrepresentation of African Americans in the sciences. In addition, this research addressed the relationship between learning styles and the science attitudes that African American middle school students have toward science. African Americans, like many students, seem to develop a dislike or a fear of science and mathematics around the middle school grades when taking these subjects becomes required. Lack of preparation in science and mathematics among minority students in late elementary and early junior high school affects enrollment and success in senior high school programs. Ultimately, this lack of preparation carries over into college (*1*).

A review of the various types of learning styles will be presented as a precursor to a specific discussion of the learning styles inventory ideas and instruments of Dunn, Dunn, and Price chosen for this study. A brief history of the views on cognitive functioning and learning styles of African American students along with a review of other cultural studies using the learning styles inventory will be provided. The status of African Americans in the sciences over the last twenty-five years as well as a discussion of factors contributing to the unequal participation of African Americans will be presented. A review of the ideas of testing science-related attitudes (TOSRA) of middle school students will be given. After the review of learning styles and science-related attitudes, the purpose, hypotheses, assumptions and delimitation of this particular study will be provided. An interpretation of the data collected from the learning styles inventory tests administered to the African American middle school students and the adults will be presented. The results of the TOSRA for the middle school students will be presented. A summary of the findings of this study and future implications of the results will conclude the research.

Learning Styles

Learning styles is a broad term and includes cognitive style as well as other styles that will be discussed. According to Claxton and Murrell (*2*) regardless of the type of style that an individual uses, style is different from ability, which they view as a characteristic of intelligence. Ability refers more to the content of cognition, while style helps to predict how information is to be processed by each individual. Trying to understand how humans learn probably goes back some 2500 years; however, Claxton and Murrell feel that from the early 1900s to the 1960s there was a lack of focus on trying to understand learning styles. They attribute this to the lack of a clear definition of learning styles, which led to contradictory findings on the topic coming from researchers representing many disciplines.

Keefe (*3*) is of the opinion that in order to have a workable approach to comprehending and describing learning styles, three areas must be understood: cognitive, affective, and physiological. According to Messick (*4*), cognitive style describes the way a person perceives things, remembers information, and solves problems. Cognitive style focuses on "how" a person learns, not "what" is learned. Witkin et al. (*5*) were the pioneers for a special profile under the cognitive domain, the dimensions of "field dependence" and "field independence." Individuals were shown a complex design and were asked to isolate the simple figure hidden within it. The authors have characterized field dependent people as being dominated by the field or the surrounding area of the complex design. These individuals are viewed as being global and sensitive to their social environment but not very analytical in their thinking. On the other hand, the background material in the design does not distract field independent people. These individuals are able to distinguish parts from the whole, are more analytical in their thinking, and are nonresponsive to their social environment.

Dunn and Dunn (*6*) explain that the affective domain of learning styles includes personality and emotional characteristics associated with areas such as the environment, persistence, control, responsibility, motivation, sociological needs, and peer and authority figure interactions. The affective domain relates to questions like: Do you prefer working or studying alone or with others? Are you more competitive or cooperative? Dunn, Dunn (*6*) and Keefe (*3*) suggest that the physiological component is biologically based and is connected to sex differences, health and nutritional concerns, and reaction to the physical environment. The physiological domain relates to questions like: Are you a morning, evening, or night person? Do you require frequent breaks? Does background music help you to concentrate while studying or does it distract you? There are problems associated with compartmentalizing concepts and ideas into precise categories because there is overlap in the meaning of many terms. However, classifying learning styles is helpful in understanding the complexity and scope of this broad field.

Reiff (*7*) explains that under the cognitive domain, four noteworthy learning profiles have generated much research and interest: Mindstyles (Gregorc's Model), Multiple Intelligences (Howard Gardner's Multiple Intelligence), Modality (Don Lowry's True Colors), and Psychological Differentiation (Herman Witkin's Field Dependence/Field Independence). Under the affective domain, Psychological Types, (The Myers-Briggs Type Indicator) has been used significantly in personality studies. Under the physiological domain, four major elements: immediate environment, emotionality, sociological needs, and physical needs will be discussed in detail along with the Learning Styles Inventory (LSI) instrument used in this study as published by Dunn, Dunn, and Price, which is based on these four elements.

Dunn, Dunn and Price Learning Styles Inventory

In 1974, Rita and Kenneth Dunn (*6*) attempted to develop a comprehensive learning styles model by incorporating four elements: environmental, sociological, emotional, and physical variables. Later, Gary Price joined their effort to complete the model, which is now widely used in secondary schools. The model consists of four major elements:

1. Environmental - These are the surrounding factors that a learner finds most conducive to learning. They are:
    a) *Sound* – noise level,
    b) *Light* – level of lighting,
    c) *Temperature* – temperature of study area, and
    c) *Design* – formal or informal learning setting.

2. Emotional - These factors are similar to the affective factors in the other learning styles models: They are:
    a) *Motivation* – the need to achieve academically and the need to please teachers,
    b) *Persistence* – the inclination to complete a task,
    c) *Responsibility* – a person's conformity level or inclination to follow instruction

(i.e. whether a person does what is expected or does things according to what he or she wants), and
d) *Structure* – the desire to have specific directions or to perform tasks independently without assistance.

3. Sociological – These factors account for a person's need for social support in a learning situation. They are:
    a) *Self-orientation* – a person's preference to work alone,
    b) *Colleague-orientation* – the individual's need to have a colleague's support in the learning process,
    c) *Authority-oriented* – the person's regard and respect toward an authority figure,
    d) *Pair-oriented* – the person learns best when working in pairs, and
    e) *Team-oriented* – the individual learns best when working with a team.

4. Physical Needs – These factors relate to a person's perceptual preferences. They are:
    a) *Perception* – the modality preferences, (i.e. auditory, visual, tactile, or kinesthetic),
    b) *Intake* – the desire to eat, drink, chew, or bite while concentrating,
    c) *Time* – the time of day that a person learns best, and
    d) *Mobility* – the need for movement during learning (*6*).

The Dunn, Dunn, and Price Learning Styles Instrument has been revised into two versions, one for students in grades 3-12 called Learning Styles Inventory (LSI) and one for adults called Productivity Environment Preferences Survey (PEPS).

LSI (Appendix A) is a self-report inventory and is designed for students in grades 3-12. There are several variations of these inventories to accommodate different grade levels. All of the questions are scored on a 3-point or 5-point Likert scale and can be administered in a paper-pencil format, orally, by tape, or by computer. The LSI surveys individual preferences in each of 22 different areas. Questions concerning each of the areas are presented. Responses tend to reveal personalized preferences that, when identified as relevant areas, represent the way in which the individual prefers to study or concentrate. The LSI reveals how students prefer to learn, not the skills they use to learn. See Appendix A for the description of each of the 22 areas.

PEPS (Appendix B) is the adult version of the self-report learning styles assessment instrument. The PEPS is similar to the LSI measuring the first 20 areas on a Likert scale but is modified for adults.

A computerized profile of the author's responses to the PEPS is shown in Appendix C. This profile, as does the profiles of all the participants, contains the individual's name, identification number, sex, date answer sheet was scored, group identification, raw score (the raw score is the arithmetic sum of the responses to the items in a given area), standard score (scale ranges from 20 to 80 with a mean of 50 and a standard deviation of 10), LSI or PEPS area, and a graph of the relative location of each person's standard score in each area. The standard score is calculated as compared to the scores of more than 500,000 students and 1,000 adults who have completed the LSI and the PEPS, respectively. Individuals having a standard score of 60 or higher have a high preference for that area when they study, concentrate, or work. Individuals having a standard score of 40 or lower with the exception of Learning Alone or with Peers and Evening/Morning, which are on a continuum, have a low preference in that area when they study, concentrate, or work. Individuals having scores that fall between 40 and 60 indicate that their preference is neither high nor low in that area. For example, a learner's preference for some type of sound (music, TV, radio, etc.) is indicated by a score of 60 or higher under the noise preference area.

The effect on student achievement when teachers teach to the learning styles of students was the subject of a meta-analysis of Dunn, Dunn, and Price's Learning Styles Inventory (LSI) conducted in 1993 by Sullivan (*8*). Her research showed that adapting instructional methods and lesson plans to match the learning style preferences of the students increased learning outcomes. The results of her investigation have been reprinted from the LSI Manual (*9*) (Appendix D).

In 1987, Curry (*10*) conducted a comparative analysis of the style conceptualizations and psychometric analyses of nine different instruments, which supposedly measured learning styles instructional preference. The LSI was the only instructional instrument rated as having good or very good reliability and validity (summative psychometric rating). The other eight instruments received ratings of poor and fair. The LSI was found to be the easiest to use and interpret. The LSI is the most broadly used assessment instrument in elementary and secondary schools, according to Keefe (*11*). Educators throughout the United States that have used the LSI have reported statistically higher test scores and/or grade point averages for students whose teachers changed from traditional teaching methods after assessing the learning styles of their students using the LSI instrument. The traditional approach is that no type of assessment is performed on the students to measure their thinking skills or preferences for learning prior to the teacher implementing standard instructional methods, materials, and lesson plans. Favorable results of applying learning styles have been shown at all levels, elementary, secondary, and college once students are made aware of their learning styles. Teachers have reported significantly higher standardized achievement and aptitude test scores for students who had not scored well previously (*11*).

The LSI does the following:

1. Permits students to identify how they prefer to learn and also indicates the degree to which their responses are consistent,
2. Suggests a basis for redesigning the classroom environment to complement students' diverse styles,

3. Describes the arrangements in which each student is likely to learn most effectively (i.e. alone, paired with two or more classmates, with a teacher, or, depending on the task, with students with similar interests or talents),

4. Explains which students should be given options and alternatives and which students need direction and a highly structured environment,

5. Provides information concerning which students are conforming and which are nonconforming and explains how to work with both types,

6. Pinpoints the best time of day for each student to be scheduled for difficult subjects, showing how to group students for instruction based on when their energy levels for learning is the highest,

7. Identifies those students for whom movement or snacks, while the students are studying, may enhance their ability to learn, and

8. Suggests those students for whom analytical versus global approaches are likely to be important (*6*).

A learning styles inventory instrument was used instead of a personality and/or intelligence test because, although important to learning, a student's personality type or intelligence quotient are more difficult for a teacher to influence, change, or address. Even though learning styles knowledge is by no means a panacea, the development of teaching methods and lesson plans based upon the learning styles of students have been shown to produce positive results (*8,10,11*).

Literature of African American Learning Styles

Educators such as Banks (*13*), Shade (*15*), Hale (*16*), and Sue and Sue (*12*) have postulated many explanations as to why African American students have been labeled not only as different but sometimes as inferior. According to Sue and Sue (*12*), these views of African American students being different or inferior arise from a society that serves to promote what is described as the *YAVIS* syndrome which favors individuals viewed as being *Y*oung, *A*ttractive, *V*erbal, *I*ntelligent, and *S*uccessful. African Americans have consistently been relegated to the edge of these categories. American society has continued, many times unknowingly, to accept biased assumptions concerning the differences between African American and Caucasian children, instead of searching for an understanding for these differences. These misrepresentations seem to be manifested in the area of cognition where African Americans are not as strong (*12*).

The misconception of the cognitive tendencies of African Americans in analytically oriented American school systems seems to foster several damaging beliefs. Banks (*13*) feels America was made aware of the idea of socioeconomic factors having great influence on the learning potential of African American students during the Civil Rights Movement of the mid-1960s. The American educational system tried to explain the lower academic achievement of impoverished students in the United States, a disproportionate number of whom were and still are African American. These efforts introduced such ideas as "cultural deprivation" and "cultural differences." The cultural deprivation theory gained the most attention in the 1960s and early 1970s and suggested that underachievement in the African American community was caused by a lack of proper socialization skills. The African American culture was viewed as inferior because many of the customs, values, beliefs, and behaviors displayed were different from those of the Caucasian culture. This way of thinking became less popular as society's feelings changed toward the belief that African Americans needed to obtain middle class status if their culture was to be validated. During the 1980s, the cultural differences theory gained greater acceptance, because differences were no longer seen as deficiencies. The cultural differences theory fostered the idea that the world view of African Americans was valid and need not be viewed as pertinent only in comparison to Caucasian American values, beliefs, and customs. Banks (*13*) concludes that while cultures share a number of overlapping beliefs, values, and behavioral style, just as important are the differences within a particular group, (i.e. gender, religion, demographics, and social status).

According to Kunjufu (*14*), there are a number of areas that impact the education of African American children. Areas such as teacher expectations, tracking, parental involvement, student self-esteem, curriculum, learning styles, test bias, and peer pressure are important factors. Kunjufu (*14*) and Banks (*13*) concur that social status is probably the most important of these variables. They point to the number of studies conducted by colleges and school districts showing a correlation between income and the number of parents in the home and academic achievement by the children. Banks (*13*) goes a step further with the assertion that people of the same social class will probably act alike, have some of the same values, and possibly learn in a similar fashion. The biggest problem with testing this theory was trying to define or delineate the different social classes; that is, lower class, middle class, upper class, and the variations in between. For example, a single parent home fifty years ago was considered lower class but is now common among the middle class. He also discovered that an African American middle class family was not the same as a Caucasian middle class family. Many times the African American family was a first generation middle class while the Caucasian family was a second, third, or fourth generation middle class. Being a first generation versus being a second, third, or fourth generation made a difference in values and perceptions. Banks (*13*) concluded that culture and class, once defined, interact to influence learning styles.

Understanding what is meant by culture and learning style is essential to understanding how African American children or others learn. Shade (*15*) sees culture as a way of viewing, judging, and organizing the thoughts, situations, and events a group of people encounters on a daily basis. Cultures may uphold certain religious teachings, language, or style of communication. The principles used by individuals to select and to understand given information are also determined by culture and culture should affect the way children learn.

Both Shade (*15*) and Banks (*13*) advocate that the learning styles of African Americans originated in the West African culture and that both the African American church and family have been highly influential in promoting these learning styles. Hale (*16*) concludes that young African American students possess more of a relational person-oriented learning style compared to Western Caucasian students. He contrasts the analytical style, common in most American classrooms, to the relational style, which is common in the African culture. The problem of students of one culture taught in an educational environment based on another culture is a foundation for a myriad of problems.

Cultural Studies Using the Learning Styles Inventory

In 1992 Ewing and Yong (*17*) researched whether significant group, gender, and grade differences existed in the preferred learning styles of gifted sixth through eighth grade minority students. Sixty-one Mexican-American (26 males, 35 females), fifty-four African American (20 males, 34 females), and forty Chinese-American (25 males, 15 females) students were given the LSI. Significant gender differences were observed in preferences for Tactile (#14) and Intake (#16) areas. The boys showed a stronger tactile preference for keeping their hands busy, while reading and for taking notes while they listened. The boys also displayed the need to eat, drink, or chew on something while performing an assignment, a preference for Intake (#16).

All three ethnic groups showed high Responsible (#7) and Motivated (#5) learning style preferences. That is, all groups were willing to conform to the rules and had the desire to achieve for their own satisfaction. African American students showed high Visual (#13) and Studying in the Afternoon (#19) preferences. Chinese-Americans demonstrated the strongest desire for the Visual (#13) learning style preference of the three groups. Visual students need to be shown pictures, diagrams, or illustrations. Mexican-Americans demonstrated a higher need for the Kinesthetic (#15) preference. Mexican Americans prefer whole-body movement and/or real life experiences to absorb and retain material. They need to act out their ideas and to express themselves (*17*).

Realistically, a teacher is not expected to know or understand completely all the learning styles of a culturally diverse classroom or expected to prepare a different lesson plan for each learning style. However, as Atwater (*18*) concludes, science teachers in particular must be familiar with the literature about learning, perceptual, and cognitive styles. Science teachers must be able to use a variety of teaching strategies for the nontraditional student who may be non-analytical or field-dependent. Teachers can accommodate a wide variety of learning styles by using a wide variety of teaching strategies that provide all students multiple opportunities to learn. Atwater (*18*) advocates demonstrating to school teachers and administrators that science classes are currently designed so that certain students have a better chance of succeeding in learning science, typically the Caucasian male student.

Teachers should design curriculum materials and lesson plans that acknowledge and relate to all cultures and races. Multicultural education is a concept that views science and the science teacher from a different perspective. According to Atwater,

> There are many definitions of multicultural education. One of the most comprehensive definitions describes multicultural education as at least three things: an idea or concept, an educational reform movement, and a process. Multicultural education incorporates the idea that all students, regardless or their gender and social class and their ethnic or cultural characteristics, should have an equal opportunity to learn in school (*18*).

Changing the environment of teaching science must start with the top administrators of school systems and flow down to the science teachers in the classrooms. If not, a majority of Americans students, especially African Americans, will be left behind in science classes.

In 1987, Jacobs (*19*) used the LSI to determine if any differences existed in the learning styles of African American high, average, and low achievers. He also compared their learning style preferences to that of Euro-American high, average, and low achievers. The classification of high, average, and low achievers was based on the local school district's Comprehensive Assessment Program (CAP) test scores. The sample population consisted of 300 students from three middle schools in the south. The results of his study showed that there were differences in learning styles according to achievement level, sex, and race.

In this section, only the results of the African American students in Jacob's (*19*) study will be discussed. However, in Chapter 3 (Results and Discussion) a comparison of the learning styles of African Americans and Euro-Americans will be provided. African

American high achievers had strong preferences for Teacher Motivation (#22). These high-achievers desired to learn and complete assignments because teachers would be pleased. The average-achievers showed high learning style preferences in the area of Auditory (#12) learning. These average-achievers learned best when information and instructions were verbalized to them or delivered through a recording. African American low achievers showed a strong preference for Persistence (#6). Low-achievers were more inclined to complete a task before taking a break. More African American male high achievers preferred "less structure" than did female average and low achievers. More African American male low achievers preferred "authority figures present" while learning than did female low achievers .

Minorities in Science

Statistical data compiled by Wild and Wilson (*20*) reveal that African Americans, Hispanics, and Native Americans are underrepresented among the population of scientists in the United States. In 1995, minorities earned only 18.0% of all bachelor's degrees, 14.0% of master's degrees, and 12.6% of doctorates. In 1993, Hispanics earned only 3.0% of bachelor's degrees, 2.9% of master's degrees, and 4% of first professional degrees while African Americans received only 6.7% of all bachelor's degrees awarded, 5.4% of master's degrees, and 5.5% of first professional degrees. Out of the 27,105 American citizens awarded doctorates in 1994, only 1,092 African Americans, 882 Hispanics, and 142 Native Americans were represented. These percentages are disproportionate to the 12.3 % African Americans, the 12.5 % Hispanics, and the 0.9% Native Americans comprising the whole population in the United States, according to the

2000 U.S. Census (*21*). These numbers have created a limited pool from which to recruit minority faculty members as reflected in the statistics on minority representation on American college and university faculties. According to Wilds and Wilson (*20*) in 1993, minorities represented only 12.2% of all teachers at any level in the United States. Of all full-time college teachers, 4.8% were African American but most of these taught in historically African American institutions. Hispanics represented 2.3% of all full-time college teachers while Native Americans were only 0.3% of all full-time college teachers in 1993. Statistical information gathered by the National Science Foundation (*22*) shows that, in 1997, underrepresented minorities (African Americans, Hispanics, and Native Americans) comprised 19% of the total workforce but only 8% of the science and engineering work force. Currently, 85% of all new workers entering the workforce in the United States are females and minorities.

As predicted earlier by Yates and Ortiz (*23*), currently, one-third of the students in American public schools are members of a minority racial or ethnic group. African Americans and Hispanics from urban settings comprise the majority of these students according to Cotton (*24*). To illustrate, in 2001 in the Mobile County, Alabama Public School System there were 108 middle school science teachers for 20 middle schools (15,000 students) but only 28 were African American (26%). There were only 3 African American male middle school science teachers (3%). The magnitude of this underrepresentation is clearly understood when compared to the fact that African Americans comprised 54% of the entire student population in the Mobile County Public School System (*25*). The five middle schools in this study were chosen from the Mobile County Public School System during the 2000-2001 school year.

As Clark (*26*) reveals, enrollment has declined for prospective African American teachers in schools of education across the nation. Teacher education programs at historically Black colleges and universities (HBCUs) are declining at an alarming rate. In 1974 HBCUs graduated 9,051 African American prospective teachers; in 1981 that number had dropped to 4,027; and below 2,200 in the year 2000. For more than a century, African American teachers were the mainstay of this country's African American professional class, but in the last 25 years, their number has dropped drastically. The fact that most professional African Americans can get higher paying jobs in other professions contributes to the decline. This decline in the number of African American teachers and consequently science and math teachers is critical in light of the large percentage of African American students enrolled in public schools. As America continues to develop into a technologically advanced society, the lack of African American students entering the teaching profession, particularly math and science, is cause for concern because only a few African American students are pursuing studies that will prepare them to teach science and math or to go into other science related fields (26).

In the HBCUs students are majoring in mathematics and the sciences but are not preparing to teach, even though these institutions have curricula options in mathematics, biology, physics, and chemistry which permit them to obtain teacher certification. The lack of African American science and math teachers to serve as role models for students is a factor in the decline of African American students' desire to pursue careers in math and science (*26*).

Rowe (*27*) explains that as students reach middle school the availability of role models becomes an important factor in their attitude and behavior towards science and the selection of careers in science. Pallone et al. (*28*) have shown that, although middle school students consider parents as the individuals most responsible for their career choices, association with individuals with specific occupations are second in importance. Students seem to emulate what they see. Whether African American students attend public or private schools, the fact remains that their teachers can make the difference in their attitudes and behavior towards science. Kunjufu (*29*) asserts that the most important factor in student performance is teacher and parent expectations, not socioeconomic status, not the home environment, not the student-per-teacher ratio, and not the school systems' per-pupil expenditure. He further suggests that when teachers show a lack of confidence in African American students' academic potential, then the students adjust their behavior in ways that meet these expectations. No one rises to low expectations. In addition, African American students sometimes hinder themselves with the belief that they cannot possibly comprehend science because of a presumed lack of ability (*29*). There is a need to provide African American students with more African American role models within science and mathematics and one way is to increase the number of African Americans teaching science and mathematics during the elementary and middle school years.

Factors of Underrepresentation

The decision by many African American students not to pursue a science-oriented career did not start in the colleges. There are a number of factors affecting their career choices. One factor is inadequate elementary and secondary school preparation. Pallone et al. (*28*) explains that for many school systems, whether predominantly African

American or predominantly Caucasian American, teaching science at the elementary level is not a priority and sometimes ignored completely. If students don't get what they need in terms of prerequisite skills and interest in science at the elementary level, especially in the case of African American students, then they will become more likely to opt out once they have a choice at the middle or high school level. If and when they reach college, they are often poorly prepared to take science courses (*28*).

Another factor contributing to the dearth of African American students in science education is the problem of understaffed and underequipped schools, especially for inner city and minority schools (*26*). Schools with a higher percentage of economically disadvantaged students, minority or not, have less to offer in terms of the latest equipment, supplies, and computers. Equipment is critical to a science curriculum, since laboratory experiences are very important. Clark (*26*) emphasizes that this economic deprivation results in a lack of preparation of African American students in science and consequently a limited pool of prepared African American students entering science related fields. Teachers and counselors should make a concerted effort to prepare and guide students toward careers in science. Not all Black students will or should pursue careers in science. However, those with the potential and aspiration should be motivated and adequately prepared to pursue such fields.

Kunjufu (*29*) concludes that educators working in the areas of science and mathematics are faced with the problems of preventing the further decline of African American students. These students need to be motivated and encouraged to participate in programs leading to degrees in the sciences. This encouragement must begin in the elementary schools where curriculum materials, instructional strategies, and appropriate role models may contribute to a positive attitude toward science and possibly change African American students' behavior and performance in the classroom.

Ignoring obvious racial and/or gender bias, Hill et al. (*30*) identified two other factors that influence the underrepresentation of African Americans in science. The first factor is "social status." The research showed that socioeconomic factors, such as parents' educational and occupational status, had an influence on students' performance in science classes and whether students chose a college major and career that was science related. Clark's (*31*) research also showed that science majors tend to be of a higher social class than nonscience majors. His belief is that any effort to address the underrepresentation of African Americans will require identifying scientific talent among lower-class African American students before they opt for nonscience majors. The work done by Pearson (*32*) showed that among the African American scientists that he surveyed, most of them were raised in families where the parents were professionals. He concludes that the underrepresentation of African Americans is probably more of a function of class than race.

According to Hill et al. (*30*), the second factor that influences the underrepresentation of African Americans is "role models and teacher encouragement." The lack of role models is believed to hinder the recruitment of young African Americans into the sciences, particularly science education. According to Pearson and Pearson (*33*), although there has been a shift in undergraduate enrollment patterns of African American students from historically Black colleges and universities (HBCUs) to Caucasian colleges and universities, the HBCUs continue to produce a disproportionately high percentage of African American scientists and engineers. A contributing factor to this trend is that the majority of the teachers at the HBCUs are African American where they are able to serve as role models for students interested in becoming science teachers and science professionals. However, these role models are not on the faculty of Caucasian colleges and universities in proportion to African American student enrollment. Not only can the African American faculty serve as role models; but also as teachers, they have a tremendous amount of influence when delivering praise and encouragement. This has an effect on African American students' attitudes toward science.

In order to understand the individual differences of learners, teachers must first understand their own learning styles. According to Steinberg (*34*), teachers have a tendency to gravitate toward and even favor students whose styles are similar to their own. If the learning styles of teachers and students are extremely different, students are often mislabeled as "slow." Teachers should help students become more aware of individual learning styles so that students can accept and appreciate their individuality with a positive attitude. African American students, in particular, need to feel their styles are valued and accepted because these styles may differ from those doing the teaching. Atwater (*18*) concludes that students should not be judged as being deficient or disadvantaged because they do not share the same beliefs, attitudes, and learning styles as the teacher.

According to Yinger (*35*), a teacher who understands learning styles can prepare more efficient lesson plans to accommodate the different learners in the classroom. He further explains that planning appropriate and varied lessons will improve both the method of instruction and the management of classroom time. Realistically, a teacher cannot be expected to have a different lesson plan for every student in the classroom.

However, lesson plans can incorporate strategies that reflect a variety of learning styles. According to Hernandez (*36*), teachers who firmly adhere to a given style will almost never reach a majority of their students, because they are too locked into one approach. Therefore, versatility is critical in the classroom if learning is to take place for all students.

Irvine (*37*) notes that African American students are often at odds with their schools because of cultural discontinuity. Their language, behavior, and learning styles have roots in the West African culture while often the teachers, administrators, and school programs are based on European culture. She explains that if Caucasian teachers do not understand the cultural characteristics of their African American students, they will view African American behavior negatively. Teachers bring their own culture and values with them into the classroom, which can bring about a conflict between their values and those of the students. Cultural discontinuity occurs more often when the Caucasian middle-class teacher, frequently female, interacts with African American male students. The Caucasian female teacher may view a male student's behavior as disruptive because of the way he talks and expresses himself. Caucasian teachers may have negative stereotypes, reinforced by the media, forcing them to make incorrect assumptions about the behavior of African American students, particularly, African American males (*37*).

Gilbert and Gay (*38*) believe that school leaders must stop operating on the supposition that all the reasons for African American students' problems with school are completely the students' fault. A large share of the blame rests with the school systems. They further emphasize that behavior was not a major problem before the integration of public schools. African American teachers customarily taught African American students, and were respected by their students. The decline of African American teachers fosters other problems in the process of educating African American students. With appropriate attitudes and respect for differences, Caucasian teachers can be effective teachers of African American students. However, research indicates that the presence of African American teachers in the classroom can have a more positive influence on students of the same culture. These authors conclude that students and teachers who share a common cognitive style, influenced by their culture, tend to perceive each other more favorably than do teachers and students whose cognitive styles are different (*38*).

In the view of Ladson-Billings (*39*), the education of Caucasian students is relatively more successful than that of African American students because the schools are designed for Caucasian education. African Americans are forced to function in this environment. The African American differences in learning styles are not recognized, respected, or valued. Too often differences in learning styles become associated with differences in ability. With America's cultural diversity, educators must realize that one method of teaching or one style of education cannot meet the needs of all students. Extra measures must be taken to train all teachers in the diversity of learning styles for the variety of learners.

Educators like Rita and Kenneth Dunn (*6*), Mary Sullivan (*8*), and James Keefe (*11*) explain that if teachers and students use the learning styles information, the learning process will be a lot more successful, take place more easily, and students will be happier when they learn. In addition, classroom attitudes improve and behavior problems decline when teachers use instructional materials and programs and design lesson plans based on how students prefer to learn. The way teachers respond to the learning styles of African American students not only impacts the way students feel about themselves but also the way they feel about science (*29*).

Review of Test of Science-Related Attitudes (TOSRA)

A discussion of the learning styles of African American students and those factors that contribute to the problem of underrepresentation of African Americans is not complete without a discussion of how African American students feel about science and scientists. This research reviews whether a correlation exists between the attitudes of middle school African American students towards science (TOSRA) and their learning styles and how both relate to their classroom behavior, lack of desire, and lack of success in the sciences. The test used to study the science-related attitudes of the students in this research was developed by Dr. Barry Fraser at Macquarie University, Sydney, Australia (*40*).

Shirley (*41*) performed extensive research in order to determine if science attitude scores could reflect science behavior in the classroom. He viewed various attitude-behavior relationships from five perspectives:

1. Attitude precedes behavior,
2. Attitude is behavior,
3. Attitude is not directly related to behavior,
4. Attitude follows behavior, and
5. Attitude and behavior are reciprocal (*41*).

He concluded that science attitudes could possibly predict science behaviors of teachers and students in the science classroom. The general belief is that positive science behavior on the part of science students should show them having an interest in learning science. Whether or not students like a subject will affect their desire to pursue a major in that field while in college.

Scott-Jones and Clark (*1*) researched the school experiences of African American girls in terms of gender, race, and socioeconomic status. They found an opposite pattern in gender differences. Girls in elementary and in high school had less positive attitudes toward science than males. However, the reverse was true for middle school, with girls being more positive toward science. In addition, on cognitive and achievement measures, the effects of race were three times greater than those attributable to the effects of gender. Caucasians in elementary school had more favorable attitudes toward science than African Americans. However, students of all races had similar attitudes about science once they reached the middle school level. Middle school seems to be a pivotal juncture for most students when it comes to attitudes and behaviors toward many issues, not just science (*1*).

White and Richardson (*42*) used the TOSRA test to compare the attitudes toward science of male and female students, African American and Caucasian students, and students from grades six, seven, and eight. Instead of evaluating all six classifications (subscales) (Table 1, Appendix G) of the TOSRA they chose to study the following three: Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, and Enjoyment of Science lessons. The first two classifications (subscales) are not the same. The first subscale is a learned tendency in a continually favorable or unfavorable way toward science. The second subscale deals with behaviors connected with critical thinking and characterizes the thinking process of scientists. These authors found that attitudes toward science improved with an increase in grade level. The eighth graders were more positive toward science than the sixth graders. Caucasian students at all grade levels had more positive scientific attitudes than non-Caucasian students. They also concluded that non-Caucasian students have lower attitudes because of the lack of exposure to science experiences. Interestingly, their results showed that female students at all grade levels had more positive attitudes toward science than male students. Finally, they concluded that students' attitudes do indeed affect their behavior and performance in class.

Purpose of the Study

There is no easy solution to the quandary of how to increase the representation of African Americans in science. This is a complex issue that is beyond the scope of any single study. Atwater (*43*) believes that as many as eight factors may affect the career choices of African American students in the sciences: career counseling by teachers and school administrators, teachers' expectations of the students, course counseling, student persistence, role models, students' attitudes toward science, early and continuous exposure to science, and students' involvement in science projects and experiment designs. The combination of the findings from the literature suggests many possible reasons for the problem of underrepresentation and a myriad of suggestions for the solution. One approach to solving the problem is to adjust teaching methods, curricula, and lesson plans based on the learning styles of African American students. Hopefully, this would increase the interest of African American students in science, give them more favorable attitudes towards learning science, and increase their desire to choose science-related careers. There is no research comparing the learning style preferences of adolescent African Americans to the learning style preferences of African American adults who have pursued science careers to see if the African Americans choosing science careers are different from the culture at large. There is also little research on the relationship between the attitudes of middle school African American students toward science and their learning styles.

The purpose of this research was to show the magnitude of the problem of underrepresentation of African Americans in the sciences, provide historical and contemporary information on learning styles and science related attitudes, present the findings from the studies on learning styles and science-related attitudes of a test group of middle school African American students, and present some ideas and strategies for addressing the enormous problem of the underrepresentation of African Americans.

Statement of Hypotheses

The hypotheses of the study are:

1. The learning style preferences of African American middle school students are different from those of African American college science students, science teachers, and science professionals.

2. The science related attitudes of African American middle school students are different from non-African American middle school students.

Assumptions

The researcher assumed the following:

1. Each participant understood the directions and questions on the respective LSI, PEPS, and TOSRA score sheets.

2. Each participant gave honest and truthful responses to the questions.

3. The Dunn, Dunn, and Price LSI and PEPS models and the Fraser TOSRA instrument were accurate assessments of the learning style preferences and science-related attitudes.

4. The LSI and PEPS models and the TOSRA instrument were not culturally biased or sexist.

Scope and Delimitations of the Study

This study was limited to only the middle school students at the following five inner-city middle schools in the Mobile County, Alabama Public School System:

1.	Calloway-Smith Middle School	100 participants
2.	Chastang Middle School.	99 participants
3.	Mae Eanes Middle School	99 participants
4.	Mobile County Training Middle School	100 participants
5.	Washington Middle School	95 participants

The makeup of the adult population was as follows:

1.	Middle Tennessee State University Science Majors	14 participants
2.	Dentists and College Professors (13 and 3)	16 participants
3.	Middle and High School Science Teachers	23 participants

The selection of the specific middle schools was based on an African American enrollment of 98% or higher. There are 20 middle schools (15,000 students) in the Mobile County, Alabama Public School System. There are 92 schools in the entire system with a total student enrollment of 66,000. African American students make up 54% of the total enrollment (*25*). The Middle Tennessee State University African American science students were volunteers enrolled in an undergraduate biochemistry class and enrolled in the graduate chemistry program. The African American science professors were faculty members in the chemistry and biology departments at Middle Tennessee State University.

The middle and high school science teachers selected were attendees at a workshop given by the author on March 28, 2001 at the School Board Office Building of the Mobile County, Alabama Public School System (MCPSS). There are 221 science teachers in the MCPSS; 53 are African American (24%). There are 108 middle school science teachers in the MCPSS; 28 are African American (26%), (*25*). The African American dentists who participated in the survey were attendees at the Annual Alabama Dental Society Conference held in Selma, Alabama on April 14, 2001.

CHAPTER 2

METHODS AND PROCEDURES

The Inventory and Survey

Learning style preferences were determined by administering the written forms of the Dunn, Dunn, and Price Learning Styles Inventory (Appendix A) to the students and the Dunn, Dunn, and Price Productivity Environment Preference Survey (Appendix B) to the adults. One hundred and four questions (LSI) and one hundred questions (PEPS) were answered on the scoring sheet using a No. 2 pencil. Both the students and the adults responded on a five-point Likert scale ranging from Strongly Disagree (SD), Disagree (D), Uncertain (U), Agree (A), or Strongly Agree (SA) to the response that best described their preference for work or study conditions for concentrating when learning new and/or difficult information or skills. The middle school students were given the inventory during their science class and were supervised by their teachers. Completion of the inventory or survey took 20 minutes. The answer sheets were computer scored by Price Systems, Inc. in Lawrence, KS. Price Systems published an individual profile and a four-page narrative on each participant. As previously discussed, the author's profile is shown in Appendix C as an example of the information provided in a complete profile on each participant.

For the LSI completed by each middle school student a consistency score was calculated based on the student's response to questions that were repeated throughout the inventory. The higher the consistency score, the greater the confidence that was placed in interpreting the student's responses. For the inventory results to be accepted and included for statistical analyses, the student had to have a consistency score of at least 70%. This indicated that responses to seventy percent of the item pairs agreed. When the consistency score fell below 70%, the teacher discussed the inventory with the student, explaining that the results were not meaningful and that the test should be taken again. Seven out of 500 inventories (1.4%) were below the acceptable consistency level, leaving 493 acceptable inventories that were used for statistical analysis. A low consistency score can be attributed to a lack of motivation, that is, not taking the test seriously, limited attention span, and/or a lack of self-awareness. However, a low consistency score was not interpreted as indicating that a student had low ability. There were no consistency scores calculated for the adults completing the PEPS. The publishers of the PEPS, along with the author, assumed that adults responded consistently to questions repeated throughout the survey.

Price Systems prepared a Group Summary for the LSI and the PEPS. A sample of the group summary for the college science students (I.D. #000012) is provided in Table 1. The author took the PEPS test as one of the 14 college science students tested. As Table 1 shows, the author indicated (score of 60 or higher) a preference for four areas, of the twenty areas tested, as important when studying or learning. Those areas were: Structure (#8), Learn Alone (#9), Authority Figure (#10), and Afternoon (#19). Table 1 also shows those areas of preference for the other thirteen college science students. The group summary was divided into two parts, subscale summaries. The first sub-scale summary was based on those students who had a standard score of 60 or higher for any given area, meaning they had a preference for that area while studying or learning. Table

TABLE 1

SAMPLE
PEPS GROUP SUMMARY FOR COLLEGE SCIENCE STUDENTS: SCORE ≥ 60
GROUP I.D.: 000012: N = 14

	SUBSCALES																			
NAME	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
X				*	*			*	*	*				*					*	
X							*					*		*		*				
X	*				*								*		*			*		
X		*						*												
X								*								*			*	*
X				*				*		*	*		*					*		
X					*	*	*	*		*		*		*					*	
X								*		*					*					
X					*	*							*	*					*	
X		*			*									*						
X																				
X					*	*	*	*		*			*							
X					*	*		*		*		*	*	*	*				*	
Perine, Don								*	*	*									*	

NOTE: Due to confidentiality, all the names have been omitted except for the author.

2 shows this for the fourteen college science students. The second sub-scale summary was based on those students having a standard score of 40 or lower, meaning they did not prefer that particular area while studying or learning. Table 3 shows this for the fourteen college science students. These summaries were used to identify which individuals in this particular group had similar preferences.

Sub-Scale Summaries for all the remaining groups that were tested using the LSI and the PEPS are presented in Tables 4 – 17. There were two printouts for each group, one printout for scores 60 or higher and one printout for scores 40 or less. However, only those summaries with a standard score of 60 or higher were used to determine which of the sub-scales or areas were significantly important to both the students and adults.

Each table consists of four columns: Area, Subscale, Response, and Percentage. The Area column indicates the name of the 20 (PEPS) and 22 (LSI) areas upon which the participants were tested during the survey. The Subscale column indicates the number assigned for a respective area. The Response column gives the number of times a respective area was selected by the respondents. The Percentage column provides the calculated number of responses for a given area divided by the total number of respondents times 100%.

Validity of Inventory and Survey

According to Price and Dunn (*9*), 21 out of 22 of the reliabilities are equal to or greater than 0.60 for the Likert scale in grades 5 through 12 for the LSI (Appendix E).

The areas with the highest reliabilities included: Noise Level, Light, Temperature, Design, Motivation, Persistence, Responsibility, Structure, Learning Alone/Peer-Oriented

TABLE 2

SUB-SCALE SUMMARY FOR COLLEGE SCIENCE STUDENTS: SCORE ≥ 60
GROUP I.D.: 000012

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	1	7.14
LIGHT	2	2	14.28
TEMPERATURE	3	0	0.00
DESIGN	4	3	21.43
MOTIVATION	5	7	50.00
PERSISTENT	6	3	21.43
RESPONSIBLE	7	3	21.43
STRUCTURE	8	9	64.29
LEARN ALONE	9	2	14.28
AUTHORITY FIG.	10	7	50.00
SEVERAL WAYS	11	1	7.14
AUDITORY	12	3	21.43
VISUAL	13	5	35.71
TACTILE	14	6	42.86
KINESTHETIC	15	3	21.43
REQ.INTAKE	16	2	14.28
EVEN-MORNING	17	0	0.00
LATE MORNING	18	2	14.28
AFTERNOON	19	6	42.86
NEED MOBILITY	20	1	7.14

Participants: 14 college students, 66 responses

TABLE 3

SUB-SCALE SUMMARY FOR COLLEGE SCIENCE STUDENTS: SCORE ≤ 40
GROUP I.D.: 000012

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	0	0.00
LIGHT	2	1	7.14
TEMPERATURE	3	1	7.14
DESIGN	4	1	7.14
MOTIVATION	5	1	7.14
PERSISTENT	6	0	0.00
RESPONSIBLE	7	2	14.28
STRUCTURE	8	0	0.00
LEARN ALONE	9	6	42.86
AUTHORITY FIG.	10	1	7.14
SEVERAL WAYS	11	2	14.28
AUDITORY	12	0	0.00
VISUAL	13	2	14.28
TACTILE	14	1	7.14
KINESTHETIC	15	0	0.00
REQ.INTAKE	16	1	7.14
EVEN-MORNING	17	3	21.43
LATE MORNING	18	5	35.71
AFTERNOON	19	0	0.00
NEED MOBILITY	20	2	14.28

Participants: 14 college students, 29 responses

TABLE 4

SUB-SCALE SUMMARY FOR SCIENCE TEACHERS: SCORE ≥ 60
GROUP I.D.: 000011

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	4	17.39
LIGHT	2	6	26.09
TEMPERATURE	3	3	13.04
DESIGN	4	0	0.00
MOTIVATION	5	7	30.43
PERSISTENT	6	5	21.74
RESPONSIBLE	7	2	8.69
STRUCTURE	8	6	26.09
LEARN ALONE	9	8	34.78
AUTHORITY FIG.	10	11	47.83
SEVERAL WAYS	11	2	8.69
AUDITORY	12	7	30.43
VISUAL	13	3	13.04
TACTILE	14	11	47.83
KINESTHETIC	15	6	26.09
REQ.INTAKE	16	7	30.43
EVEN-MORNING	17	2	8.69
LATE MORNING	18	3	13.04
AFTERNOON	19	8	34.78
NEED MOBILITY	20	2	8.69

Participants: 23 teachers, 103 responses

TABLE 5

SUB-SCALE SUMMARY FOR SCIENCE TEACHERS: SCORE ≤ 40
GROUP I.D.: 000011

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	2	8.69
LIGHT	2	1	4.35
TEMPERATURE	3	3	13.04
DESIGN	4	2	8.69
MOTIVATION	5	1	4.35
PERSISTENT	6	2	8.69
RESPONSIBLE	7	3	13.04
STRUCTURE	8	4	17.39
LEARN ALONE	9	4	17.39
AUTHORITY FIG.	10	0	0.00
SEVERAL WAYS	11	8	34.78
AUDITORY	12	1	4.35
VISUAL	13	3	13.04
TACTILE	14	1	4.35
KINESTHETIC	15	1	4.35
REQ.INTAKE	16	3	13.04
EVEN-MORNING	17	6	26.09
LATE MORNING	18	3	13.04
AFTERNOON	19	3	13.04
NEED MOBILITY	20	2	8.69

Participants: 23 teachers, 53 responses

TABLE 6

SUB-SCALE SUMMARY FOR SCIENCE PROFESSIONALS: SCORE ≥ 60
GROUP I.D.: 000022

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	1	6.25
LIGHT	2	2	12.50
TEMPERATURE	3	2	12.50
DESIGN	4	5	31.25
MOTIVATION	5	2	12.50
PERSISTENT	6	2	12.50
RESPONSIBLE	7	3	18.75
STRUCTURE	8	3	18.75
LEARN ALONE	9	5	31.25
AUTHORITY FIG.	10	5	31.25
SEVERAL WAYS	11	1	6.25
AUDITORY	12	4	25.00
VISUAL	13	1	6.25
TACTILE	14	7	43.75
KINESTHETIC	15	1	6.25
REQ.INTAKE	16	1	6.25
EVEN-MORNING	17	3	18.75
LATE MORNING	18	4	25.00
AFTERNOON	19	3	18.75
NEED MOBILITY	20	1	6.25

Participants: 16 professionals, 56 responses

TABLE 7

SUB-SCALE SUMMARY FOR SCIENCE PROFESSIONALS: SCORE ≤ 40
GROUP I.D.: 000022

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	0	0.00
LIGHT	2	0	0.00
TEMPERATURE	3	4	25.00
DESIGN	4	1	6.25
MOTIVATION	5	0	0.00
PERSISTENT	6	0	0.00
RESPONSIBLE	7	1	6.25
STRUCTURE	8	1	6.25
LEARN ALONE	9	2	12.50
AUTHORITY FIG.	10	0	0.00
SEVERAL WAYS	11	6	37.50
AUDITORY	12	1	6.25
VISUAL	13	2	12.50
TACTILE	14	2	12.50
KINESTHETIC	15	1	6.25
REQ.INTAKE	16	4	25.00
EVEN-MORNING	17	0	0.00
LATE MORNING	18	3	18.75
AFTERNOON	19	2	12.50
NEED MOBILITY	20	2	12.50

Participants: 16 professionals, 32 responses

TABLE 8

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≥ 60
GROUP I.D.: CALLOWAY-SMITH: 000001

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	10	10.00
LIGHT	2	9	9.00
TEMPERATURE	3	17	17.00
DESIGN	4	14	14.00
MOTIVATION	5	30	30.00
PERSISTENT	6	13	13.00
RESPONSIBLE	7	28	28.00
STRUCTURE	8	41	41.00
LEARN ALONE	9	22	22.00
AUTHORITY FIG.	10	23	23.00
SEVERAL WAYS	11	21	21.00
AUDITORY	12	14	14.00
VISUAL	13	42	42.00
TACTILE	14	22	22.00
KINESTHETIC	15	22	22.00
REQ.INTAKE	16	22	22.00
EVEN-MORNING	17	23	23.00
LATE MORNING	18	17	17.00
AFTERNOON	19	22	22.00
NEED MOBILITY	20	14	14.00
PARENT MOT.	21	30	30.00
TEACHER MOT.	22	19	19.00

Participants: 100 students, 475 responses

TABLE 9

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≤ 40
GROUP I.D.: CALLOWAY-SMITH: 000001

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	37	37.00
LIGHT	2	26	26.00
TEMPERATURE	3	22	22.00
DESIGN	4	9	9.00
MOTIVATION	5	16	16.00
PERSISTENT	6	26	26.00
RESPONSIBLE	7	12	12.00
STRUCTURE	8	6	6.00
LEARN ALONE	9	21	21.00
AUTHORITY FIG.	10	19	19.00
SEVERAL WAYS	11	19	19.00
AUDITORY	12	38	38.00
VISUAL	13	14	14.00
TACTILE	14	21	21.00
KINESTHETIC	15	18	18.00
REQ.INTAKE	16	18	18.00
EVEN-MORNING	17	18	18.00
LATE MORNING	18	29	29.00
AFTERNOON	19	14	14.00
NEED MOBILITY	20	30	30.00
PARENT MOT.	21	13	13.00
TEACHER MOT.	22	25	25.00

Participants: 100 students, 451 responses

TABLE 10

SUB-SCALE SUMMARY FOR STUDENTS: SCORE $\geq$ 60
GROUP I.D.: CHASTANG: 000002

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	11	11.11
LIGHT	2	12	12.12
TEMPERATURE	3	23	23.23
DESIGN	4	5	5.05
MOTIVATION	5	29	29.29
PERSISTENT	6	18	18.18
RESPONSIBLE	7	35	35.35
STRUCTURE	8	35	35.35
LEARN ALONE	9	21	21.21
AUTHORITY FIG.	10	18	18.18
SEVERAL WAYS	11	17	17.17
AUDITORY	12	16	16.16
VISUAL	13	22	22.22
TACTILE	14	18	18.18
KINESTHETIC	15	17	17.17
REQ.INTAKE	16	25	25.25
EVEN-MORNING	17	19	19.19
LATE MORNING	18	20	20.20
AFTERNOON	19	28	28.28
NEED MOBILITY	20	24	24.24
PARENT MOT.	21	18	18.18
TEACHER MOT.	22	18	18.18

Participants: 99 students, 449 responses

TABLE 11

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≤ 40
GROUP I.D.: CHASTANG: 000002

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	29	29.29
LIGHT	2	24	24.24
TEMPERATURE	3	16	16.16
DESIGN	4	14	14.14
MOTIVATION	5	15	15.15
PERSISTENT	6	32	32.32
RESPONSIBLE	7	10	10.10
STRUCTURE	8	10	10.10
LEARN ALONE	9	19	19.19
AUTHORITY FIG.	10	20	20.20
SEVERAL WAYS	11	20	20.20
AUDITORY	12	26	26.26
VISUAL	13	18	18.18
TACTILE	14	23	23.23
KINESTHETIC	15	21	21.21
REQ.INTAKE	16	16	16.16
EVEN-MORNING	17	14	14.14
LATE MORNING	18	19	19.19
AFTERNOON	19	10	10.10
NEED MOBILITY	20	11	11.11
PARENT MOT.	21	14	14.14
TEACHER MOT.	22	18	18.18

Participants: 99 students, 399 responses

TABLE 12

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≥ 60
GROUP I.D.: MAE EANES: 000003

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	7	7.07
LIGHT	2	15	15.15
TEMPERATURE	3	16	16.16
DESIGN	4	8	8.08
MOTIVATION	5	34	34.34
PERSISTENT	6	12	12.12
RESPONSIBLE	7	48	48.48
STRUCTURE	8	37	37.37
LEARN ALONE	9	24	24.24
AUTHORITY FIG.	10	13	13.13
SEVERAL WAYS	11	16	16.16
AUDITORY	12	10	10.10
VISUAL	13	21	21.21
TACTILE	14	16	16.16
KINESTHETIC	15	22	22.22
REQ.INTAKE	16	19	19.19
EVEN-MORNING	17	11	11.11
LATE MORNING	18	17	17.17
AFTERNOON	19	27	27.27
NEED MOBILITY	20	24	24.24
PARENT MOT.	21	27	27.27
TEACHER MOT.	22	21	21.21

Participants: 99 students, 445 responses

TABLE 13

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≤ 40
GROUP I.D.: MAE EANES: 000003

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	33	33.33
LIGHT	2	19	19.19
TEMPERATURE	3	19	19.19
DESIGN	4	12	12.12
MOTIVATION	5	12	12.12
PERSISTENT	6	23	23.23
RESPONSIBLE	7	8	8.08
STRUCTURE	8	10	10.10
LEARN ALONE	9	12	12.12
AUTHORITY FIG.	10	19	19.19
SEVERAL WAYS	11	21	21.21
AUDITORY	12	35	35.35
VISUAL	13	16	16.16
TACTILE	14	18	18.18
KINESTHETIC	15	22	22.22
REQ.INTAKE	16	19	19.19
EVEN-MORNING	17	23	23.23
LATE MORNING	18	20	20.20
AFTERNOON	19	8	8.08
NEED MOBILITY	20	21	21.21
PARENT MOT.	21	16	16.16
TEACHER MOT.	22	19	19.19

Participants: 99 students, 398 responses

TABLE 14

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≥ 60
GROUP I.D.: MOBILE COUNTY TRAINING: 000004

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	5	5.00
LIGHT	2	21	21.00
TEMPERATURE	3	21	21.00
DESIGN	4	8	8.00
MOTIVATION	5	40	40.00
PERSISTENT	6	15	15.00
RESPONSIBLE	7	46	46.00
STRUCTURE	8	44	44.00
LEARN ALONE	9	39	39.00
AUTHORITY FIG.	10	27	27.00
SEVERAL WAYS	11	19	19.00
AUDITORY	12	11	11.00
VISUAL	13	31	31.00
TACTILE	14	18	18.00
KINESTHETIC	15	19	19.00
REQ.INTAKE	16	16	16.00
EVEN-MORNING	17	12	12.00
LATE MORNING	18	19	19.00
AFTERNOON	19	30	30.00
NEED MOBILITY	20	24	24.00
PARENT MOT.	21	24	24.00
TEACHER MOT.	22	26	26.00

Participants: 100 students, 515 responses

TABLE 15

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≤ 40
GROUP I.D.: MOBILE COUNTY TRAINING: 000004

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	45	45.00
LIGHT	2	29	29.00
TEMPERATURE	3	19	19.00
DESIGN	4	14	14.00
MOTIVATION	5	9	9.00
PERSISTENT	6	25	25.00
RESPONSIBLE	7	7	7.00
STRUCTURE	8	7	7.00
LEARN ALONE	9	18	18.00
AUTHORITY FIG.	10	15	15.00
SEVERAL WAYS	11	14	14.00
AUDITORY	12	40	40.00
VISUAL	13	17	17.00
TACTILE	14	24	24.00
KINESTHETIC	15	22	22.00
REQ.INTAKE	16	15	15.00
EVEN-MORNING	17	30	30.00
LATE MORNING	18	23	23.00
AFTERNOON	19	8	8.00
NEED MOBILITY	20	17	17.00
PARENT MOT.	21	9	9.00
TEACHER MOT.	22	13	13.00

Participants: 100 students, 420 responses

TABLE 16

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≥ 60
GROUP I.D.: WASHINGTON: 000005

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	15	15.79
LIGHT	2	11	11.58
TEMPERATURE	3	17	17.89
DESIGN	4	5	5.26
MOTIVATION	5	29	30.53
PERSISTENT	6	7	7.37
RESPONSIBLE	7	32	33.68
STRUCTURE	8	47	49.47
LEARN ALONE	9	29	30.53
AUTHORITY FIG.	10	18	18.95
SEVERAL WAYS	11	26	27.37
AUDITORY	12	18	18.95
VISUAL	13	21	22.11
TACTILE	14	33	34.74
KINESTHETIC	15	28	29.47
REQ.INTAKE	16	25	26.32
EVEN-MORNING	17	14	14.74
LATE MORNING	18	24	25.26
AFTERNOON	19	20	21.05
NEED MOBILITY	20	33	34.74
PARENT MOT.	21	31	32.63
TEACHER MOT.	22	18	18.95

Participants: 95 students, 500 responses

TABLE 17

SUB-SCALE SUMMARY FOR STUDENTS: SCORE ≤ 40
GROUP I.D.: WASHINGTON: 000005

LSI AREA	SUBSCALE	RESPONSES	PERCENTAGE
NOISE LEVEL	1	22	23.16
LIGHT	2	27	28.42
TEMPERATURE	3	17	17.89
DESIGN	4	14	14.74
MOTIVATION	5	6	6.32
PERSISTENT	6	21	22.11
RESPONSIBLE	7	6	6.32
STRUCTURE	8	9	9.47
LEARN ALONE	9	12	12.63
AUTHORITY FIG.	10	16	16.84
SEVERAL WAYS	11	10	10.53
AUDITORY	12	26	27.37
VISUAL	13	21	22.11
TACTILE	14	16	16.84
KINESTHETIC	15	11	11.58
REQ.INTAKE	16	18	18.95
EVEN-MORNING	17	17	17.89
LATE MORNING	18	15	15.79
AFTERNOON	19	5	5.26
NEED MOBILITY	20	20	21.05
PARENT MOT.	21	8	8.42
TEACHER MOT.	22	12	12.63

Participants: 95 students, 329 responses

Learner, Authority Figures Present, Learn in Several Ways, Auditory, Visual, Tactile, Kinesthetic Preferences, Requires Intake, Evening/Morning, Afternoon, Needs Mobility, Parent Figure Motivated, and Teacher Motivated. The area with the lowest reliability of 0.56 was the Late Morning preference. As for the PEPS, the areas with highest reliabilities included: Motivation, Persistent, Responsible (conforming), Structure, Learning Alone/Peer-Oriented, Learn in Several Ways, Auditory, Visual, Kinesthetic, Requires Intake, Evening/Morning, Late Morning, Afternoon, and Needs Mobility. The areas with low reliability scores included Authority Figures and Tactile Preferences.

The TOSRA Survey

The Test of Science-Related Attitudes (TOSRA) as developed by Fraser (*40*) was used to measure seven distinct science-related attitudes among the middle school students. These attitude scales are classified as shown in the left column of Table 1 in Appendix G (Name and Classification of Each Scale in TOSRA) along with the six aims (subscales) measured by each scale, shown in the right column of the table. The material in Appendix G has been either retyped or reprinted, with permission, from selected pages of the TOSRA Handbook (*44*).

The students rated the statements on a scale of strongly disagree (1) to strongly agree (5). The first aim (subscale) was “Manifestation of Favorable Attitudes toward Science and Scientists.” Two examples of questions that measured the first subscale were: “Working in a science laboratory would be an interesting way to earn a living,” and, “I would like to teach science when I leave school.” The second aim was “Acceptance of Scientific Inquiry as a Way of Thought.” Two examples of the types of questions were: “I would rather solve a problem by doing an experiment than to be told the answer,” and, “I would prefer to do an experiment on a topic than to read about it in science magazines.” The third aim was “Adoption of Scientific Attitudes.” Two examples were: “The country is spending too much money on science,” and, “Too many laboratories are being built at the expense of the rest of education.” The fourth aim was “Enjoyment of Science Learning Experiences.”

Two examples of questions were: “Scientists do not care about their working conditions,” and, “Scientists do not have enough time to spend with their families.” “Development of Interest in Science and Science Related Activities” was the fifth aim of the TOSRA. Two examples were: “I dislike science lessons,” and, “School should have more science lessons each week.”

The sixth and final aim was “Development of Interest in Pursuing a Career in Science.” Two examples were: “I enjoy reading about things which disagree with my previous ideas,” and, “I dislike reading newspaper articles about science.” See Appendix G for the complete test with all the questions.

Scope of TOSRA

Table 1 in Appendix G provides the name of the seven scales contained in TOSRA, along with the six subscales (H.1-H.6) measured by each scale. As shown in the table, two separate TOSRA scales were included to measure two separate aims in category H.1, while each of the other five TOSRA scales measured aims in one of the remaining categories, H.2 through H.6. Since subscale H.1 (Manifestation of favorable attitudes towards science and scientists) addresses two fairly distinct subcategories, manifestation of favorable attitudes towards science and manifestation of favorable attitudes towards scientists, a separate measure of each was included in TOSRA. Although both of these subcategories cover a range of related attitudes, the test series was restricted to a reasonable size by including a measure of a single aspect of each subcategory.

The Social Implication of Science (S) scale in TOSRA measures one aspect of manifestation of favorable attitudes towards science, namely attitude towards the social benefits and problems that accompany any advancement in science. The Normality of Scientists scale (N) measures one aspect of manifestation of favorable attitudes towards scientists given importance in science education, namely an understanding that scientists are normal people rather than unconventional as often depicted in the media (*40*).

The third scale, listed in Table 1 of Appendix G, the Attitude to Inquiry (I) scale, measures attitude to scientific experimentation and investigation as ways of gaining knowledge about the natural world. This attitude is quite similar in meaning to category H.2. (Acceptance of Scientific Inquiry as a Way of Thought). The fourth scale in TOSRA, the Adoption of Scientific Attitudes (A), measures attitudes almost identical in meaning to category H.3. (Adoption of Scientific Attitudes). The meaning of the aims measured by the last three scales listed in Table 1 of Appendix G is identical to categories H.4 to H.6 and is reflected in the titles of these three scales, Enjoyment of Science Lessons (E), Leisure Interest in Science (L) and Career Interest in Science (C). Each scale in TOSRA can be furthered clarified by examining the actual items in each scale. Appendix II in Appendix G indicates which items fall into each of the seven scales, while Appendix I in Appendix G gives the instructions and scoring for the test (*44*).

Response Format of TOSRA Items

The questions for each TOSRA item were graded on a Likert scale, with each statement on a five-point scale consisting of the responses Strongly Agree (SA), Agree (A), Not Sure (N), Disagree (D), and Strongly Disagree (SD).

Scoring involved assigning a point value of 5, 4, 3, 2, 1 for the responses SA, A, N, D, SD, respectively, for questions designated as positive (+) and assigning a point value of 1, 2, 3, 4, 5 for the responses SA, A, N, D, SD, respectively, for questions designated as negative (-) *(44)*.

Uses of TOSRA

According to Fraser (*40*), teachers or researchers can use TOSRA to monitor progress towards achieving a more favorable attitude towards science. A teacher might employ TOSRA to obtain information about the science-related attitudes of individual students or an entire class. This could be done at the beginning of the school term and performed again at various intervals leading to the end of the year. For example, the attitudes of a group of students could be monitored after the implementation of a learning styles-based instructional program.

Fraser (*40*) states that one advantage that TOSRA has over some other science attitude tests is that it yields a separate score for a number of different attitudes being tested instead of a single overall score, making it possible to obtain a profile of attitude scores for groups of students. An example of such a profile is provided in Figure 1 in Appendix G where the data for the sample of 1337 students involved in the original field-testing of TOSRA are reported (*44*). There are difficulties in making absolute interpretations of scores on TOSRA. Interpretation of results requires teachers to compare the scores obtained by their students with the average scores obtained by a larger and broader sample.

The mean scores of the middle school students in this study were compared to the mean scores obtained on the larger sample of 1337 students in grades 7-10 as conducted by Fraser (*44*) in the original field-testing of TOSRA. The means for the field-testing sample are provided in Table 3 in Appendix G. Since students at different grade levels tended to obtain similar scores, the mean scores are plotted on a grid to form the single profile shown in Figure 1 in Appendix G. A difference of only one mark between scores obtained by a particular group of students and the field-testing sample of Fraser (*44*) may not be very meaningful. However, differences approaching one square on the grid should be viewed as significantly different. Table 4 in Appendix G provides cross-validation of the data for students tested in Australia and the United States.

Procedures

Permission to survey human subjects was obtained from the Middle Tennessee State University Institutional Review Board (Appendix H). Additional permission to survey the middle school students in the five schools was obtained from Ms. Leevones G. Dubose, Southeastern Consortium for Minorities in Engineering (SECME) Program Director, of the Mobile County, Alabama Public School System (Appendix I) and the principals of the five middle schools (Appendix J).

Notification that participation in the study was voluntary and that individual identities would remain anonymous was provided in the Individual Questionnaire & Consent Form, which all participants signed (Appendix K).

Statistical Analysis of Data for LSI and PEPS

Each participant's standard score from the LSI and the PEPS was entered into the Stat View ® statistical program published by SAS Institute, Cary, North Carolina. To determine the existence of any significant difference between the middle school students and the adults, a single factorial Multivariate Analysis of Variance (MANOVA) was performed. The Stat View® and MANOVA are computer programs provided by Dr. T. Sutarso in the Department of Academic Services (Middle Tennessee State University).

If the probability for differences in scores between the two groups was less than 0.05 (confidence level) for any of the twenty areas (subscales), then the pattern of preference for that particular area was significantly different between the two groups, meaning, that area was differentially important (not important in the same way or to the same degree) to the adults or the students as a preference for learning. However, when the difference was greater than 0.05 that learning styles area was important to both groups. The Between-Subjects Factors, the Descriptive Statistics, and the Tests of Between-Subject Effects, generated from MANOVA, are provided in Appendices L, M, and N, respectively. The data from the Test of Between-Subjects Effects show that eight of the areas (subscales) of preference of the twenty areas tested had values of 0.05 or less, which were significant. The other twelve areas showed no significant difference between the adults and the students for a given area as a preference for learning.

Statistical Analysis of Data for TOSRA

Table 2 in Appendix G provides the grade levels (7, 8, 9, & 10), the number of classes (44), and the number of students (1337) involved in the original field-testing of

TOSRA. Tables 2, 3, and 4 in Appendix G, provide all the statistical data used for validating and proving the reliability of TOSRA.

CHAPTER 3

RESULTS AND DISCUSSION

Discussion of Hypotheses

The hypotheses for this study were evaluated in light of the data obtained, which can be found summarized in Tables 3-22 and Figures 1-6.

Hypothesis (1):

The learning style preferences of African American middle school students are different from those of African American college science students, science teachers, and science professionals.

Table 18 shows the learning style preferences among the African American adult population surveyed in this study. The adult population was comprised of college science students, science teachers (middle and high school), and science professionals (college science professors and dentists). The percentage numbers represent their preferences for a particular area, when studying or working, in comparison to all 20 areas. The percentages were calculated by dividing the number of favorable responses for a specific area by the total number of respondents. Only those areas that had statistical values greater than 0.05, as previously explained in the section, Statistical Analysis of Data for LSI and PEPS, were selected for discussion. What follows are the top twelve areas.

Subscale (#14) – TACTILE (44.81%). These adults prefer to use manipulative and three-dimensional materials and resources should be touchable and movable as well

TABLE 18

SUB-SCALE SUMMARY FOR ADULTS: SCORE ≥ 60

Subscale	000012	000011	000022	Average
1	7.14	17.39	6.25	10.26
2	14.28	26.09	12.50	17.62
3	0.00	13.04	12.50	8.51
4	21.43	0.00	31.25	17.56
5	50.00	30.43	12.50	30.98
6	21.43	21.74	12.50	18.56
7	21.43	8.69	18.75	16.29
8	64.29	26.09	18.75	36.38
9	14.28	34.78	31.25	26.77
10	50.00	47.83	31.25	43.03
11	7.14	8.69	6.25	7.36
12	21.43	30.43	25.00	25.62
13	35.71	13.04	6.25	18.33
14	42.86	47.83	43.75	44.81
15	21.43	26.09	6.25	17.92
16	14.28	30.43	6.25	16.99
17	0.00	8.69	18.75	9.15
18	14.28	13.04	25.00	17.44
19	42.86	34.78	18.75	32.13
20	7.14	8.69	6.25	7.36
21	-	-	-	-
22	-	-	-	-

Group I.D.: 000012, college science students; 000011, middle and high school science teacher; 000022, professionals consisting of college science teachers (3) and dentists (13).

as readable. They need to be allowed to plan, demonstrate, report, and evaluate with models and other real objects and encouraged to keep written records.

Subscale (#10) – AUTHORITY FIGURES PRESENT (43.03%). These individuals should be placed near appropriate instructors or supervisors and scheduled numerous meetings with the supervisors or instructors. Their work should be checked often and they should be provided frequent feedback about their perceptual strengths. Adults placed a higher value of importance on this area of preference than the students.

Subscale (#8) – STRUCTURE (36.38%). These adults desire for their assignments or instructions to be precise (permitted no options). They should be given clearly stated objectives in simple form, leaving nothing for interpretation, and clearly indicated time requirements and the resources that may be used. As tasks are completed their assignments can be gradually lengthened and they can be allowed some choices from among approved alternative procedures.

Subscale (#5) - MOTIVATION (30.98%). These adult learners should be encouraged to use self-designed objectives, procedures, and evaluation before the instructor or supervisor assesses effort. They should be permitted self-pacing and rapid achievement.

Subscale (#19) – AFTERNOON (32.13%). These individuals should be permitted to schedule difficult tasks in the afternoon. Advantage should be taken of their strongest segment of the time energy curve for the afternoon.

Subscale (#12) – AUDITORY (25.62%). These adults like to learn by listening. They desire to use videotapes, records, radio, television, and be given precise oral directions when given an assignment, setting a task, reviewing progress, using resources, or for any aspect of the task requiring understanding, performance, progress, or evaluation.

Subscale (#9) – LEARN ALONE/PEER ORIENTED (26.77%). These individuals like to be paired or teamed with colleague-oriented or authority-oriented individuals that compliment their sociological characteristics. They are receptive to small-group training techniques. They are cooperative learners.

Subscale (#13) – VISUAL (18.33%). These learners like to use pictures, filmstrips, computers, graphs, transparencies, diagrams, drawings, books, and magazines while learning. They should be provided resources that require reading and seeing. These individuals should be allowed to read the material before hearing a lecture.

Subscale (#15) – KINESTHETIC (17.92%). These individuals should be provided opportunities for real and active experiences for planning and carrying out objectives. Site visits, seeing projects in action, and becoming physically involved are appropriate activities for these individuals.

Subscale (#18) – LATE MORNING (17.44%). These individuals should be scheduled difficult tasks in the late morning if not in the evening.

Subscale (#16) – REQUIRES INTAKE (16.99%). These individuals should be provided frequent opportunities for food breaks, food at workstations, and beverages at their desks.

Subscale (#7) – RESPONSIBLE (16.29%). These individuals should be given short-term assignments; as these assignments are successfully completed, the length and scope should be gradually increased. They should be challenged at the level of their functional ability or slightly beyond.

There are no right or wrong preference choices. The choices describe how African American adults prefer to function, learn, concentrate, and perform in their occupational or educational activities in the areas of: (a) immediate environment, (b) emotionality, (c) sociological needs, and (d) physical needs. Noteworthy is that these adults did not show a particular pattern of preference for those areas that related to the immediate environment (i.e. sound, temperature, light, and design). However, there were high preferences for the areas involved with physical needs (i.e. time of day, intake, and mobility), and those areas that involved interacting or relating with people.

Table 19 shows the learning style preferences of the middle school students in this study. What follows are the top twelve areas (subscales), in decreasing order by percentage of students choosing that area as important.

Subscale (#8) – STRUCTURE (41.44%). These students want the teacher to give them a lot of detail about how assignments should be completed. These students want to know how long assignments should be, if the assignment should be typed, if the assignment should be double-spaced or not, and how many subheadings, etc. They want clear direction before they work on assignments.

Subscale (#7) – RESPONSIBLE (38.30%). These students are willing to follow through when someone asks them to do something. They like to please others, particularly authority figures (i.e. teachers and parents).

Subscale (#5) – MOTIVATION (32.83%). These students like doing things on their own and being creative. They generally like school and are motivated to learn.

Subscale (#13) – VISUAL (27.71%). These students remember best by reading and seeing things. Since this score is higher than the auditory score, these students have

TABLE 19

SUB-SCALE SUMMARY: SCORE ≥ 60

Subscale	000001	000002	000003	000004	000005	Average
1	10.00	11.11	7.07	5.00	15.79	9.79
2	9.00	12.12	15.15	21.00	11.58	13.77
3	17.00	23.23	16.16	21.00	17.89	19.06
4	14.00	5.05	8.08	8.00	5.26	8.08
5	30.00	29.29	34.34	40.00	30.53	32.83
6	13.00	18.18	12.12	15.00	7.37	13.13
7	28.00	35.35	48.48	46.00	33.68	38.30
8	41.00	35.35	37.37	44.00	49.47	41.44
9	22.00	21.21	24.24	39.00	30.53	27.40
10	23.00	18.18	13.13	27.00	18.95	20.05
11	21.00	17.17	16.16	19.00	27.37	20.14
12	14.00	16.16	10.10	11.00	18.95	14.04
13	42.00	22.22	21.21	31.00	22.11	27.71
14	22.00	18.18	16.16	18.00	34.74	21.82
15	22.00	17.17	22.22	19.00	29.47	21.97
16	22.00	25.25	19.19	16.00	26.32	21.75
17	23.00	19.19	11.11	12.00	14.74	16.00
18	17.00	20.20	17.17	19.00	25.26	19.73
19	22.00	28.28	27.27	30.00	21.05	25.72
20	14.00	24.24	24.24	24.00	34.74	24.24
21	30.00	18.18	27.27	24.00	32.63	26.42
22	19.00	18.18	21.21	26.00	18.95	20.67

Group I.D.: 000001, Calloway-Smith; 000002, Chastang; 000003, Mae Eanes; 000004, Mobile County Training; 000005, Washington Middle School the need for their parents or teachers to give them directions, instructions, or assignments in writing.

Subscale (#9) – LEARN ALONE/PEER ORIENTED (27.40%). These students like to study and interact with others. They desire pairing or teams when performing assignments. They demonstrate the cooperative style of learning.

Subscale (#19) – AFTERNOON (25.72%). These students are most productive during the afternoon. They should work, study, and take their difficult classes during the afternoon when their energy curve is highest.

Subscale (#15) – KINESTHETIC (21.97%). These learners require whole-body movement and/or real-life experiences to absorb and retain material to be learned. They learn most easily when they are totally involved. Acting, drama, interviewing, and role-playing are examples of kinesthetic learning.

Subscale (#16) – REQUIRES INTAKE (21.75%). This area describes those students who often eat, drink, chew, or bite objects while concentrating as opposed to those who prefer no intake until after they have finished studying.

Subscale (#14) – TACTILE (21.82%). These students prefer to underline as they read, take notes when they listen, and keep their hands busy particularly since their auditory score is low.

Subscale (#10) – AUTHORITY FIGURES PRESENT (20.05%). These students feel better or more comfortable when someone with authority or recognized special knowledge is present.

Subscale (#18) – LATE MORNING (19.73%). These students should be scheduled their most difficult tasks in the late morning if not in the evening.

Subscale (#12) – AUDITORY PREFERENCES (14.04%). These students like to learn by listening. They need to use videotapes, records, radio, television, and be given precise oral directions when given an assignment, setting a task, reviewing progress, using resources, or for any aspect of the task requiring understanding, performance, progress, or evaluation.

These choices describe how African American students prefer to function, learn, concentrate, and perform in their educational environment in the areas of: (a) immediate environment, (b) emotionality, (c) sociological needs, and (d) physical needs. As was the case with the African American adults, these students did not show a particular pattern of preference for those areas that related to the immediate environment (i.e. sound, temperature, light, and design) as compared to physical needs (i.e. time of day, intake, and mobility), and those areas that involved interacting or relating with people.

In order to address Hypothesis (1), Table 20 gives a direct comparison of the learning style preferences of the adults and the students' preferences in those areas where both groups had percent responses at 14% or higher. Table 20 shows that the learning style preferences of the students were not statistically different from the adults' preferences in those areas such Motivation (#5), Structure (#8), Learn Alone/Peer Oriented (#9), Visual (#13), Kinesthetic (#15), Requires Intake (#16), Late Morning (#18), and Afternoon (#19). The areas of Authority Figure Present (#10), Responsible (#7), Auditory (#12),and Tactile (#14) show up in the twelve areas as important to both the adults and the students based on the percentage response values. However, these areas also show up as significantly different, meaning that while important to both groups independently these areas are not important to the same extent or in the same direction.

TABLE 20

LEARNING STYLE PREFERENCES COMPARISON ADULTS' AVERAGES VS. STUDENTS' AVERAGES SUB-SCALE SUMMARY: SCORE $\geq$ 60

AREAS	ADULTS	STUDENTS
MOTIVATION	30.98	32.83
STRUCTURE	36.38	41.44
RESPONSIBLE	16.29	38.30
LEARN ALONE/PEER ORIENTED	26.77	27.40
AUTHORITY FIGURE PRESENT	43.03	20.05
AUDITORY	25.62	14.04
VISUAL	18.33	27.71
TACTILE	44.81	21.82
KINESTHETIC	17.92	21.97
REQUIRES INTAKE	16.99	21.75
LATE MORNING	17.44	19.73
AFTERNOON	32.13	25.72
PARENT MOTIVATED	-	26.42
TEACHER MOTIVATED	-	20.67

The areas of Parent Motivated (#21) and Teacher Motivated (#22) applied only to the students. As shown in Table 19, the students in this study had a high preference for parent (26.42%) and teacher (20.67%) involvement in their learning process. On the basis of the data presented, Hypothesis (1) is not supported.

The learning style preferences of the African American adults and students found in this study substantiates what has been suggested by educators like Jacobs (*19*), Ewing and Yong (*17*), and Kunjufu (*29*). These preferences are summarized by Ford et al (*45*) as follows:

1. African Americans are mostly visual, followed by kinesthetic learners.
2. African Americans prefer a more structured learning environment.
3. African Americans are cooperative learners, preferring to study and interact with others.
4. African Americans are sensitive to what others feel and think.
5. African Americans are more responsive to rewards, smiles, and praises from teachers and authority figures.
6. African Americans are relational and less analytical in their thinking.
7. African Americans are not morning people but have their highest energy level in the afternoon.
8. African Americans rely heavily on visual aids rather than auditory aids.
9. African Americans learn better when they can focus on the whole task rather than on parts (field dependent) (*45*).

This study did not address the learning styles of Caucasian middle school students in the Mobile County Public School System. For the five middle schools involved in this study, 98% of the student enrollment is African American as is the case throughout the Mobile County Alabama Public School system. There is no school in the Mobile County

Public School System with a 98% Caucasian enrollment *(24)*. Since no LSI data were collected with Caucasian students no direct comparison can be made in this study. A myriad of studies have been conducted on the learning styles of Caucasian students, the Caucasian male especially. One particular study by Jacobs (*19*) showed that Euro-American students displayed a strong preference for Lights (#3) compared to African Americans. In addition, Caucasian students were less Teacher Motivated (#22) compared to African American students who have a stronger need for teacher and parent involvement. Finally, Caucasian students showed a lower preference for Structure (#8) compared to African American students. Jacobs (*19*) concluded that while a student's preferences for learning are personally unique to the individual, cultural and socioeconomic influences play a role.

Hypothesis (2):

The science related attitudes of African American middle school students are different from those of non-African American middle school students.

Figures 1 - 5 show the profiles of the TOSRA mean scores for the African American students from the five inner city middle schools chosen for this study plotted on a grid. Table 21 shows a comparison of the TOSRA mean scores for all five schools to the national mean score, published by Fraser (*44*). Figure 6 profiles the TOSRA mean score for all five schools in comparison with the profile of the national mean scores as plotted on a grid. There is virtually no difference in the attitudes these students have toward science and students nationwide based on the position of each score in the grid for each of the seven categories.

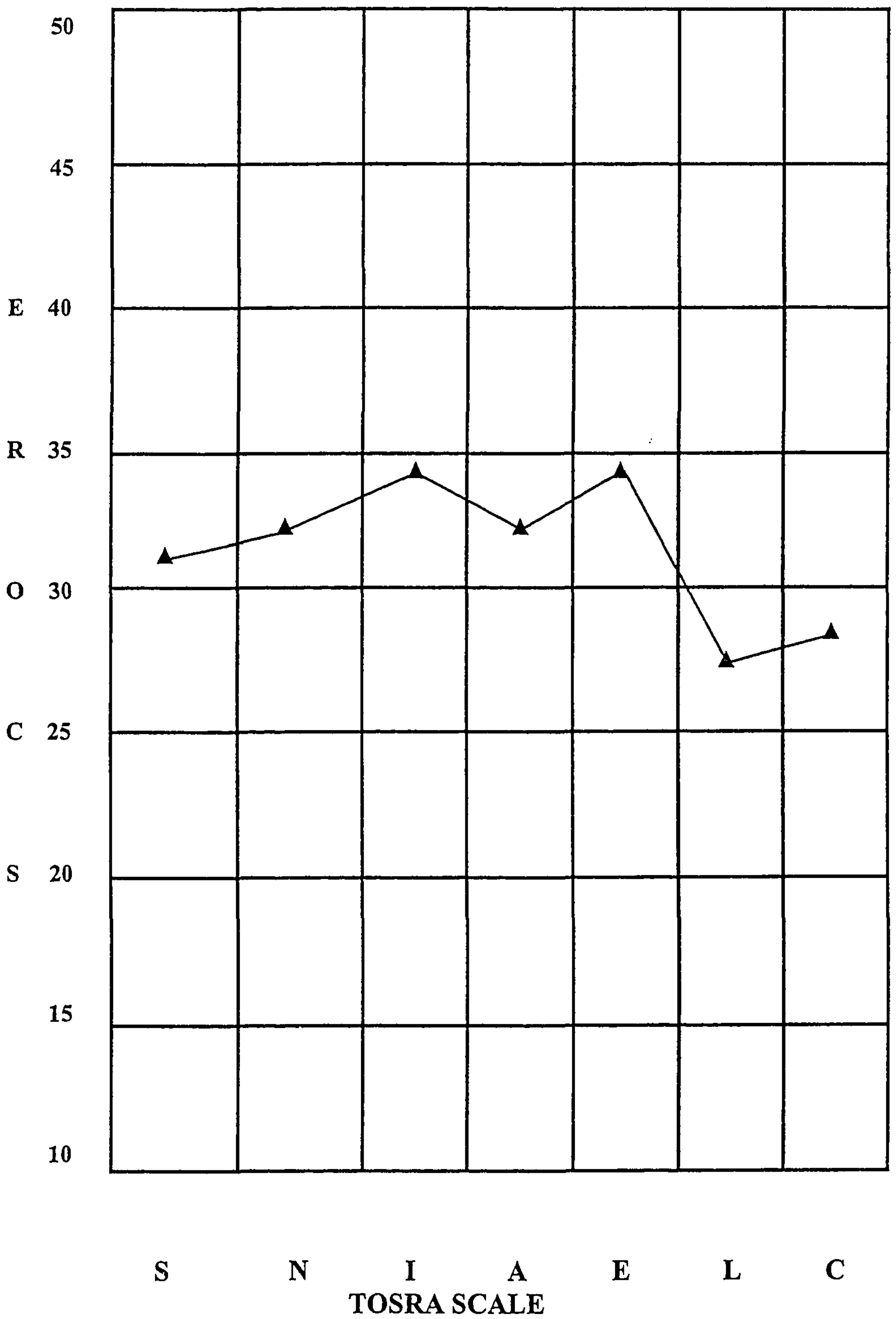

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Figure 1: Profile of the TOSRA Mean Scores for Calloway-Smith: #000001

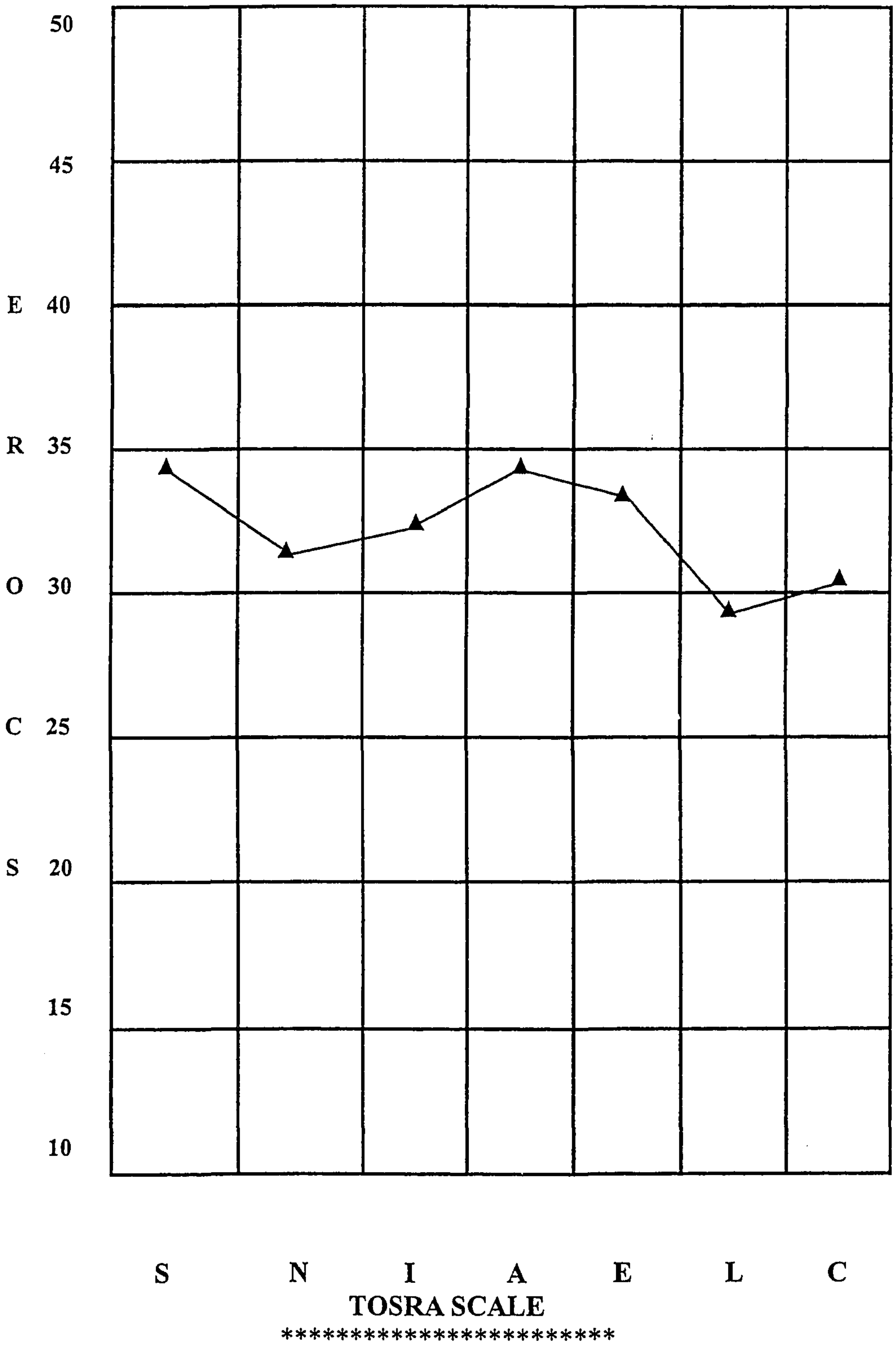

Figure 2: Profile of the TOSRA Mean Scores for Chastang: #000002

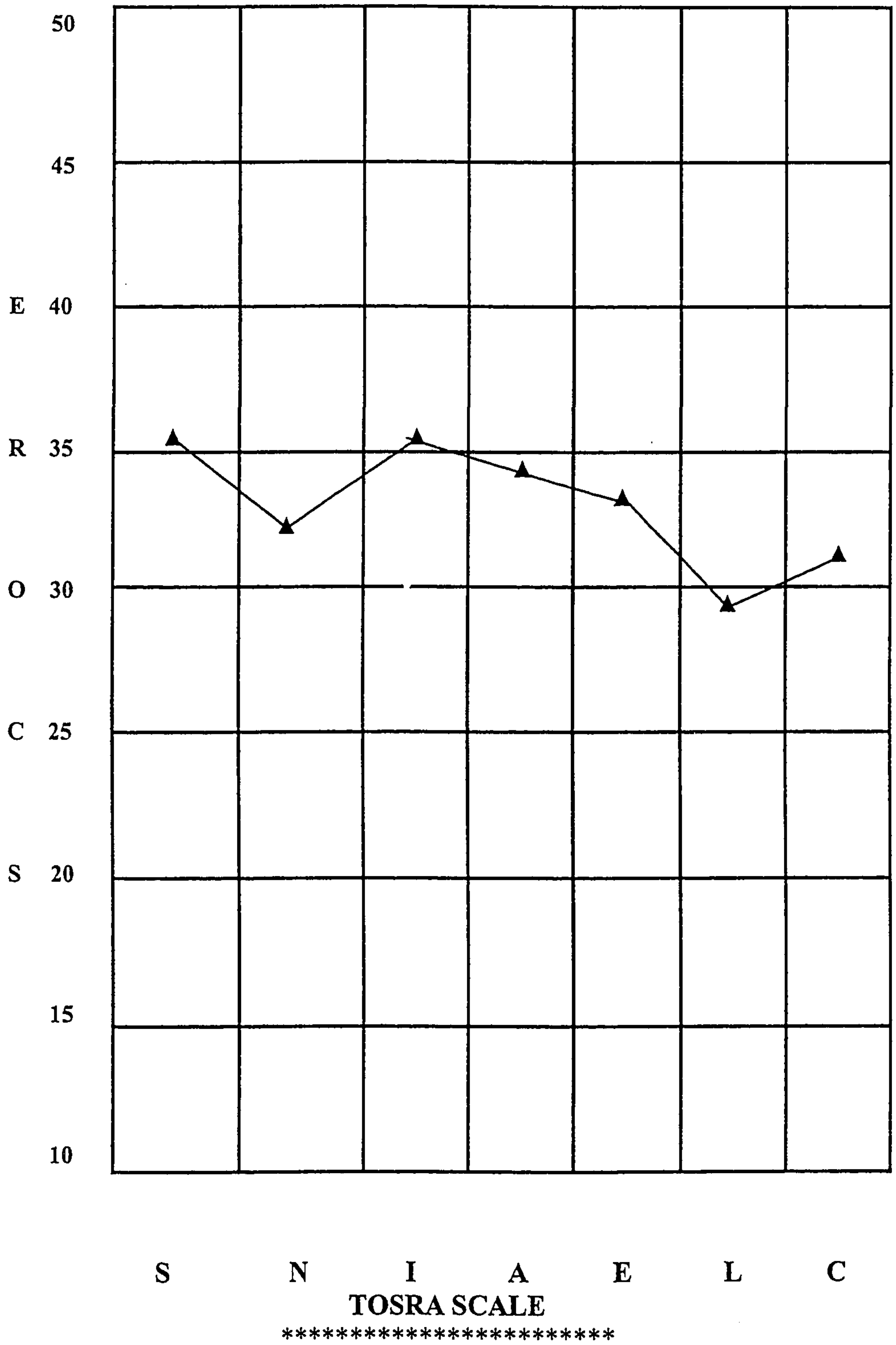

Figure 3: Profile of the TOSRA Mean Scores for Mae Eanes: #000003

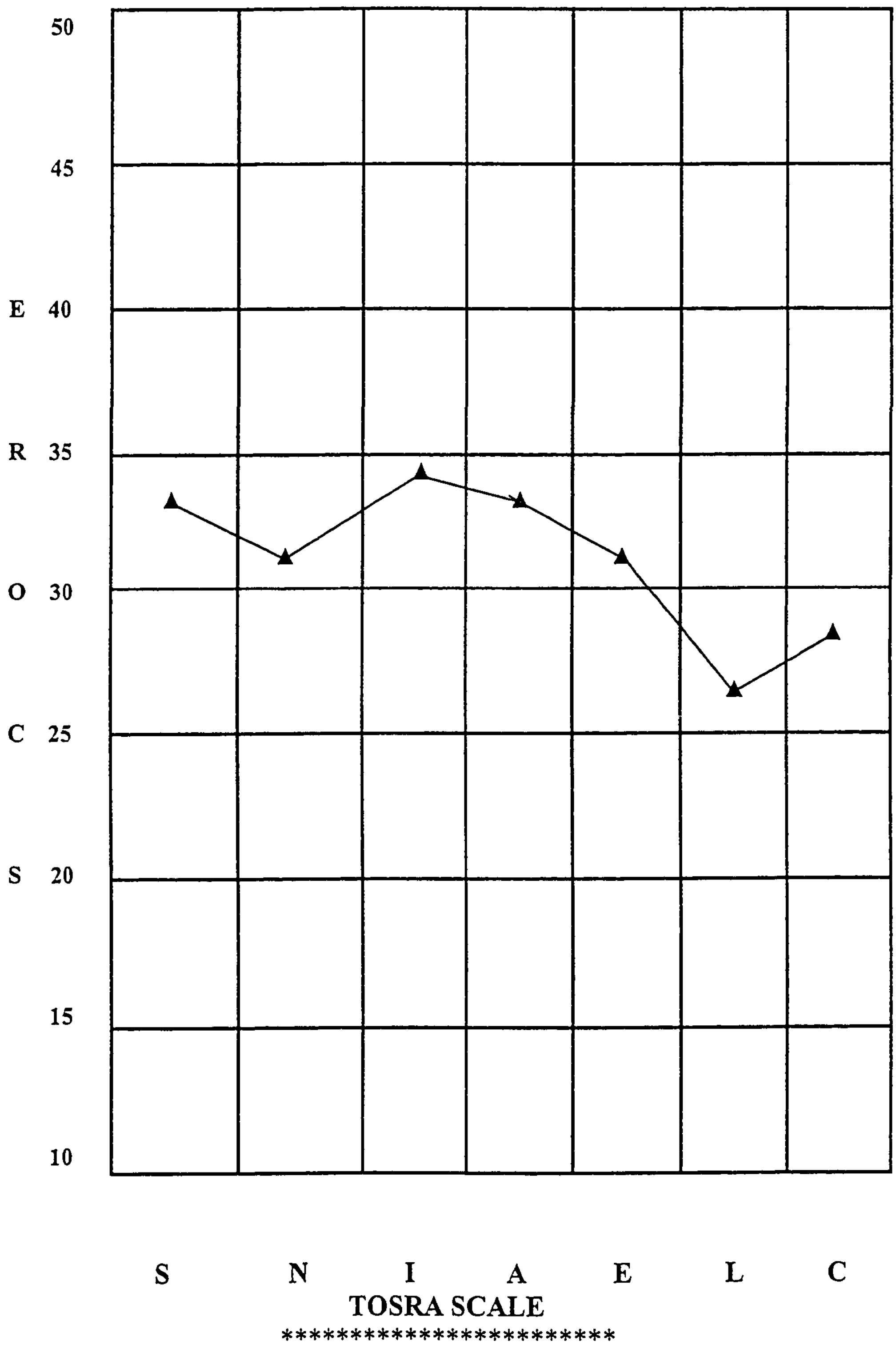

Figure 4: Profile of the TOSRA Mean Scores for Mobile County Training: #000004

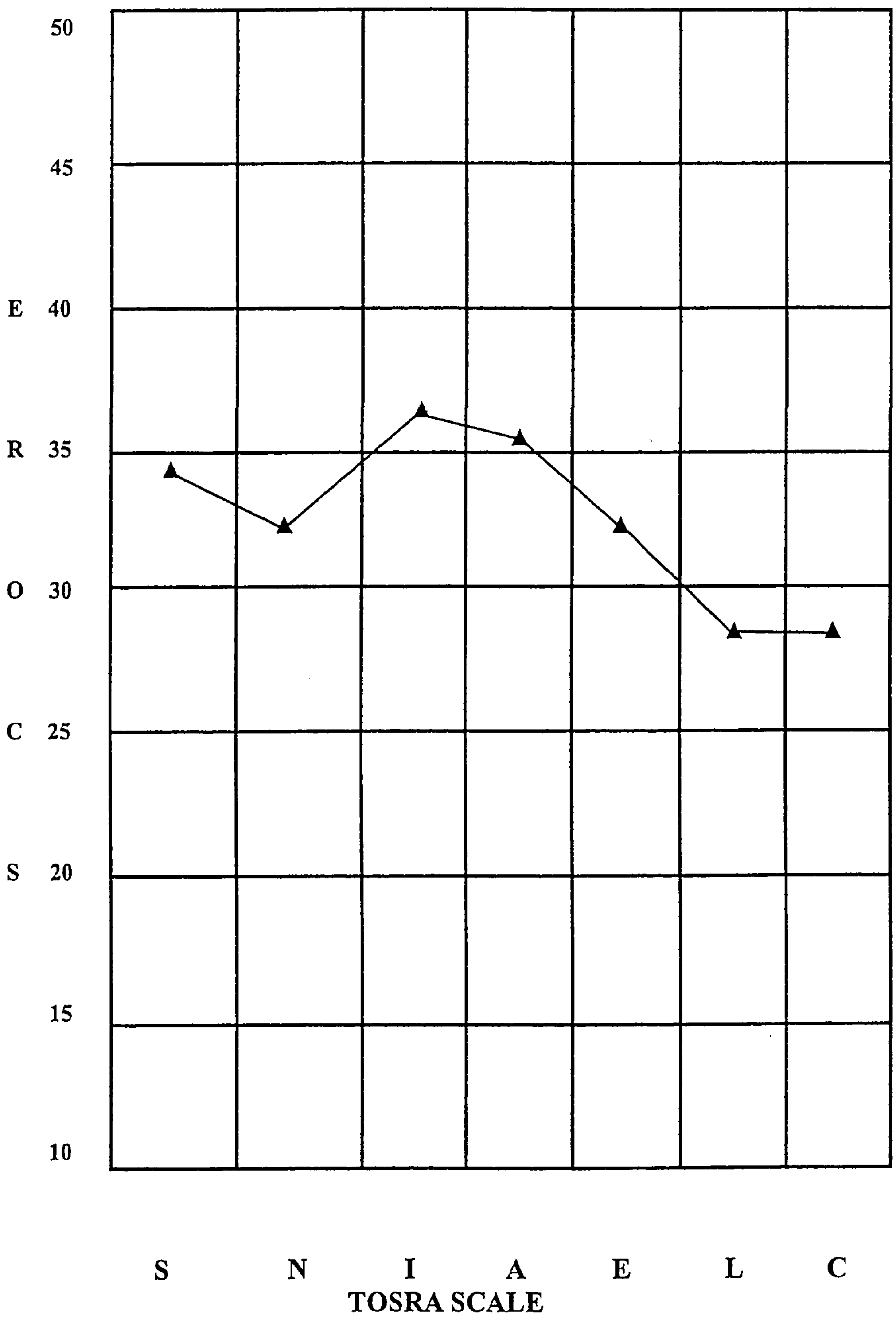

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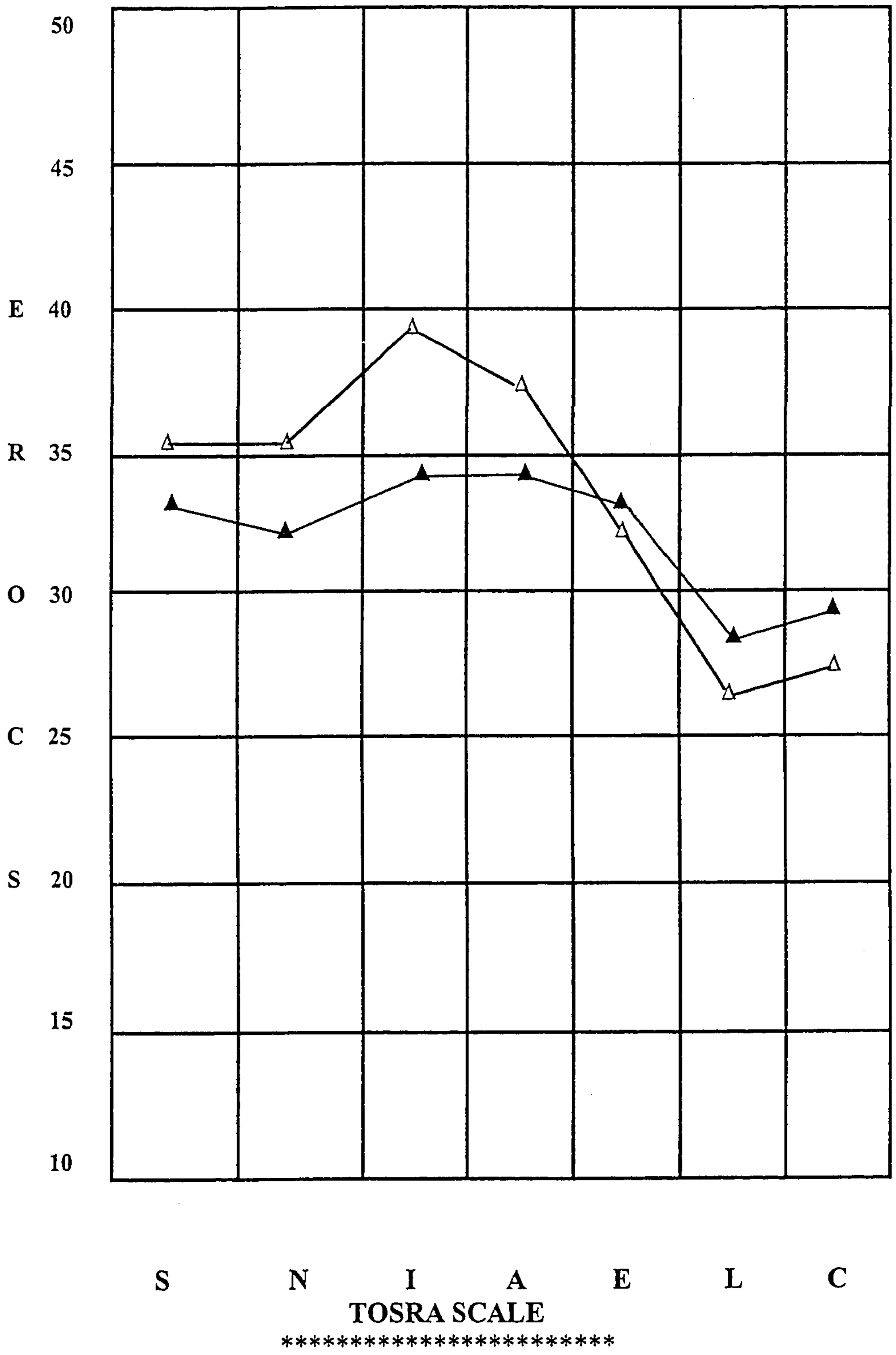
Figure 5: Profile of the TOSRA Mean Scores for Washington: #000005

TABLE 21

TOSRA
MEANS SCORE COMPARISON OF MIDDLE SCHOOLS

SCHOOL	S	N	I	A	E	L	C
#000001	32	33	35	33	35	28	29
#000002	35	32	33	35	34	29	31
#000003	36	33	36	35	34	30	32
#000004	34	32	35	34	32	27	29
#000005	35	33	37	36	33	29	29
MEAN	34	33	35	35	34	29	30
NAT'L MEAN	36	36	40	38	33	27	28



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▲ :Represents the Schools' Mean Scores

Δ :Represents the National Mean Scores

Figure 6: Profile of the TOSRA Mean Scores, All Five Schools, Compared to the National Mean Scores

The national mean scores are provided in Figure 1 in Appendix E. As suggested by Fraser (*44*), the means scores for the five schools individually and collectively are plotted on a grid to form the single profile for direct comparison to the national scores. While differences of only one mark between scores obtained by the middle school students in this study may not be very meaningful, differences approaching one square on the grid are likely to be educationally important. There is a one square difference between the students tested in this study and the students tested nationally in the area of Attitude to Scientific Inquiry (I); suggesting that the students in this study appear to have a less positive attitude toward scientific experimentation and investigation as ways of gaining knowledge about the natural world. As the profiles show, the students' attitudes toward science are virtually the same at each school and collectively the students' attitudes are not significantly different from the national group, based on the position of the scores on the grid, with the exception of Attitude to Scientific Inquiry (I). However, both groups have high scores in the areas of Attitude to Scientific Inquiry (I) and Adoption of Scientific Attitudes (A). Both groups have low scores in the areas of Leisure Interest in Science (L) and Career Interest in Science (C).

In addition to the grid plots, a chi-square test of significance was performed on the mean scores for the five schools in comparison to the national mean scores as shown in Table 22. The value of chi-square is 1.544, meaning that the probability that the author would be making an error, assuming the scores of the students from the five schools are independent (significantly different) from the national scores, is 96% ($p=0.956$); this suggests that these values are similar.

TABLE 22

CHI-SQUARE (X^2) ANALYSIS
THE FIVE SCHOOLS' MEAN SCORES
VERSUS THE NATIONAL MEAN SCORES

	S	N	I	A	E	L	C
SCHOOLS	34	33	35	35	34	29	30
NATIONAL	36	36	40	38	33	27	28
$\frac{(f_o - f_e)^2}{f_e}$	0.111	0.250	0.625	0.237	0.030	0.148	0.143
X^2	1.544						
P Value	0.957						

f_o = observed value for the five schools' mean score in each category.

f_e = observed value for the national mean score in each category.

$$X^2 = \sum \frac{[(f_o - f_e)^2]}{[\ f_e\ ]}$$

In conclusion, the attitudes of the students toward science and scientists are very consistent regardless of the students' backgrounds. They all seem to respect scientists, accept scientific inquiry as a way of thinking, and accept scientific attitudes with curiosity and open-mindedness. While these attitudes toward science are generally benevolent, most students are not very interested in participating in science activities for pleasure or becoming scientists. On the basis of the data presented, Hypothesis (2) is not supported.

The learning styles and TOSRA profiles of the middle school students that participated in these studies were submitted to their teachers for distribution and discussion with the students and their parents.

CHAPTER 4

CONCLUSIONS AND IMPLICATIONS

In an effort to learn more about the issue of underrepresentation of African Americans, this study has examined the learning styles of African American middle school students, the learning styles of African American adults in science, and the science related attitudes of African American middle school students.

The knowledge gained from this study leads the author to conclude that curricula, lesson plans, and instructional programs in science should be adapted to accommodate the learning styles of African Americans from elementary to graduate school. Perhaps learning styles should even be considered by employers within the science professions as a means to enhance productivity by better meeting the needs of workers since the trends found in learning styles are fairly consistent over time. Even though learning style characteristics may change to a small degree as African Americans advance from adolescence to adulthood, selected environmental, emotional, sociological, and physical traits appear to be stable over time. African American adults currently in science are not significantly different from the culture of African Americans at large with respect to learning styles based on this sample. It should be noted that while the sample of adults in this study is small (n=16), the population of African American adults in science is also small, which was part of the motivation for this study. African Americans in science did not have learning styles more compatible with the way science is taught in this country; instead they chose to pursue science based on other motivating factors. They are in science fields not because of their learning styles but in spite of them. Studying those factors that influence the adult African Americans in science to be in science is an issue for future research.

The data from the TOSRA were interesting indeed. Either students' attitudes toward science and scientists are not influenced by race, learning styles, and the way they are being taught or middle school students have no inherent interest in science and this probably will not change regardless of what educators do. Both of these options are, no doubt, extremes but clearly what middle school students value is a societal issue that goes beyond schools. This media driven entertainment culture does not hold science in high regard nor does it hold scientists up as role models. The data showed that students are generally benevolent toward scientists but middle school students of every race are not interested in pursuing science as a career. Clearly, more research could be done in this area to clarify where students get their images or what they can become and when the decision to become a scientist happens within the development process.

The data from this study and the literature support the importance of respected authority figures and role models to the African American learner. Those ideas and strategies purposed by Ford et al. (*45*) should be developed to allow increased participation on the part of teachers, parents, and science professionals in the science education process. The solution to the problem of underrepresentation is exacerbated by the problem itself. Teachers, parents, and other authority figures heavily influence African American students. If there were more African American science teachers and professionals to serve as role models, then the attitudes and behaviors that the students have with regard to science would be positively impacted. This would lead to more

African American students pursuing science careers. African American students are influenced most by that to which they are exposed and there are far fewer role models in science on display in the media than there are role models in sports and entertainment.

Implications

Since this study was conducted to better understand the issue of underrepresentation of African Americans in science in general and to improve the science education of students in the Mobile County Alabama Public School System specifically, it is appropriate to look at some implications of this study. The curriculum and instructional practices for the students in this study are mandated by the Alabama State Department of Education as written in the *Alabama Course of Study for Science Bulletin* (*46*). The Alabama K-12 science curriculum is based on the guidelines of the *National Science Education Standards* produced by the National Research Council (NRC). The minimum required program for Grades 6-8 is an inquiry-based approach in the domains of Physical Science, Life Science, and Earth and Space Science. To achieve scientific literacy, the programs are to place emphasis on the importance of teaching science every day to every student in every grade. In the elementary grades, Alabama teachers are instructed to start nurturing the children's interest, observations, and impressions. As the students mature and pass into middle school the earlier concepts are expected to be expanded to include more complete understanding and complex applications (*46*). There are no checks and balances to see if the middle school teachers are following the state mandates in terms of what they teach.

This information and materials are designed to tell the teachers *what* to teach, *where* to teach, *when* to teach, and *why* to teach, but not *how* to teach. Teachers are given *"academic freedom"* when it comes to methods of delivering learning material regardless of the fact that the National Science Education Standards includes standards on how science is to be taught. Academic freedom should not be a license to turn science into another time for reading during the day. There are no guidelines, instructions, and/or programs provided by the Alabama State Department of Education regarding learning styles and the importance of understanding the various styles that a multicultural school system will have. Interested teachers are expected to pursue these endeavors on their own time and use their own financial resources.

To take full advantage of learning styles would involve the active restructuring of entire school systems, teacher training programs, curriculum and instructional techniques, and the support of parents, teachers, staff personnel, administrators, and entire communities, but there are things individual classroom teachers can do. The information gained in this study leads the author to support the ideas fostered by Ford et al. (*45*) in the publication, *"Strategies for Teaching Science to African American Students."* These educators provide teachers and administrators with the following ideas and strategies for improving the opportunities of African American students:

1. Teachers should be sensitive to the fact that there are learning style differences and that such differences should be respected.
2. Administrators should encourage their Caucasian teachers to learn about the culture of their minority students by providing in-service programs especially for Caucasian teachers with African American students.
3. Teachers should follow-up with those African American students expressing an interest in advanced science courses because many African American students often do not follow through due to anxiety or outside influences.
4. Teachers should permit students to bring life experiences into the science classroom environment. African American students tend to perform best when content is related to previous experiences.

5. Teachers should incorporate the historical and contemporary contributions of African Americans in the science curriculum.

6. Teachers should display flexibility in the context of a structured learning environment based on the cultural diversity of the students.

7. Teachers and administrators should take advantage of corporate programs, which provide speakers to encourage the interest of African American students in science and technical careers by serving as role models.

8. Teachers should furnish African American students with updated information on careers in science and provide materials that show African Americans engaging in science activities or occupations.

9. Teachers and administrators should help parents of African American students to understand their role in encouraging their children's interest in science by establishing workshops and career fairs for parents (*45*).

Specifically, African American students prefer to know where they are going, globally, before they begin learning step-by-step details. Teachers need to have applications built around lessons that help the students who are field dependent. Career fairs involving the teachers, students, parents and science professionals should be conducted annually. School systems should provide funding for teachers to attend workshops and conferences and take additional courses on learning styles. This represents a mere sampling of what could be done to take advantage of learning style preferences.

As a result of this study and with the aid of the National Science Foundation (NSF), the Southeastern Consortium for Minorities in Engineering (SECME), The University of Mobile's College of Arts and Sciences, and the Mobile County Public School System, the author plans to develop a science camp program to be conducted over a three-week period during the summers for African American middle school students. The students will perform hands-on experiments in chemistry, biology, and physics.

Students will also be exposed to minority role models in science through the establishment of a visiting scientist program. Scientists and engineers from various businesses will be solicited to discuss science or engineering principles and to provide on-site visits to their places of employment. At the end of the program, the students, parents, and professionals will all meet sociably to discuss mentoring programs.

Summary

The purpose of this research was to show the magnitude of the problem of underrepresentation of African Americans in the sciences, to provide historical and contemporary information on learning styles and science related attitudes, to present the findings from the studies on learning styles and science-related attitudes of a test group of middle school African American science students, and to present some ideas and strategies for addressing the enormous problem of the underrepresentation of African Americans in the sciences based on this data.

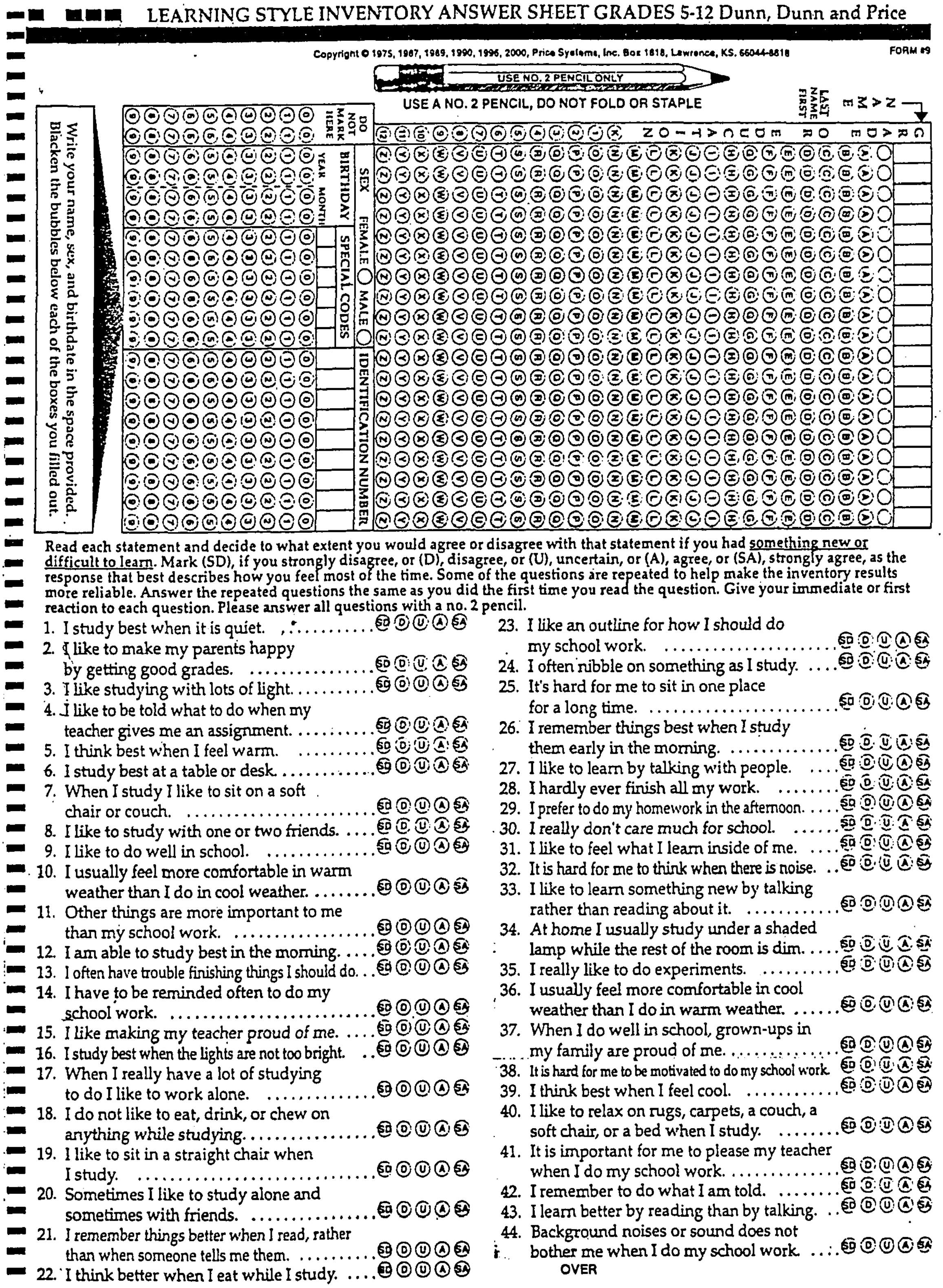
The importance of addressing the problem of the underrepresentation of African Americans in the sciences is best expressed with a quote from the keynote speech delivered by Dr. Eli Pearce, President, American Chemical Society, during the 30th Anniversary Conference of the National Organization for the Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE),

> The economic competition of nations is just like the Olympics. The United States does well in the Olympics because every citizen can take part. But a nation that cuts a quarter of the population out of the sciences is like a skater with one skate, a hockey team without a goalie. You don't win many gold metals that way. I want a prosperous America. So for the chemical industry to reflect the diversity that is America would be good not just for African Americans. It would be good for everyone (*47*).

Taking into account the ways in which African American students learn best has potential for increasing the number of African Americans who will be successful in the study of science and continue to pursue it as a career. The changes could be as simple as teachers starting lessons with a real world application which needs to be understood or solved thereby establishing a context for the learning which is important to field dependent students. The changes could be as complex as restructuring entire school systems with respect to time so that more is done in the late afternoon when African American students are at their best. Increasing the diversity of people in science professions means that there are more people who think in diverse ways and therefore more opportunities to ask new questions and to find new answers. Enhancing the opportunities in science for all citizens has the potential to benefit society at large.

APPENDIX A

Learning Style Inventory Answer Sheet and Description of the Areas



LEARNING STYLE INVENTORY ANSWER SHEET GRADES 5-12 Dunn, Dunn and Price

FORM #9

USE NO. 2 PENCIL ONLY

USE A NO. 2 PENCIL, DO NOT FOLD OR STAPLE

NAME LAST NAME FIRST

GRADE OR EDUCATION

DO NOT MARK HERE

BIRTHDAY YEAR MONTH

SEX FEMALE ○ MALE ○

SPECIAL CODES

IDENTIFICATION NUMBER

Write your name, sex, and birthdate in the space provided. Blacken the bubbles below each of the boxes you filled out.

Read each statement and decide to what extent you would agree or disagree with that statement if you had something new or difficult to learn. Mark (SD), if you strongly disagree, or (D), disagree, or (U), uncertain, or (A), agree, or (SA), strongly agree, as the response that best describes how you feel most of the time. Some of the questions are repeated to help make the inventory results more reliable. Answer the repeated questions the same as you did the first time you read the question. Give your immediate or first reaction to each question. Please answer all questions with a no. 2 pencil.

1. I study best when it is quiet. .... SD D U A SA
2. I like to make my parents happy by getting good grades. .... SD D U A SA
3. I like studying with lots of light. .... SD D U A SA
4. I like to be told what to do when my teacher gives me an assignment. .... SD D U A SA
5. I think best when I feel warm. .... SD D U A SA
6. I study best at a table or desk. .... SD D U A SA
7. When I study I like to sit on a soft chair or couch. .... SD D U A SA
8. I like to study with one or two friends. .... SD D U A SA
9. I like to do well in school. .... SD D U A SA
10. I usually feel more comfortable in warm weather than I do in cool weather. .... SD D U A SA
11. Other things are more important to me than my school work. .... SD D U A SA
12. I am able to study best in the morning. .... SD D U A SA
13. I often have trouble finishing things I should do. .... SD D U A SA
14. I have to be reminded often to do my school work. .... SD D U A SA
15. I like making my teacher proud of me. .... SD D U A SA
16. I study best when the lights are not too bright. .... SD D U A SA
17. When I really have a lot of studying to do I like to work alone. .... SD D U A SA
18. I do not like to eat, drink, or chew on anything while studying. .... SD D U A SA
19. I like to sit in a straight chair when I study. .... SD D U A SA
20. Sometimes I like to study alone and sometimes with friends. .... SD D U A SA
21. I remember things better when I read, rather than when someone tells me them. .... SD D U A SA
22. I think better when I eat while I study. .... SD D U A SA
23. I like an outline for how I should do my school work. .... SD D U A SA
24. I often nibble on something as I study. .... SD D U A SA
25. It's hard for me to sit in one place for a long time. .... SD D U A SA
26. I remember things best when I study them early in the morning. .... SD D U A SA
27. I like to learn by talking with people. .... SD D U A SA
28. I hardly ever finish all my work. .... SD D U A SA
29. I prefer to do my homework in the afternoon. .... SD D U A SA
30. I really don't care much for school. .... SD D U A SA
31. I like to feel what I learn inside of me. .... SD D U A SA
32. It is hard for me to think when there is noise. .... SD D U A SA
33. I like to learn something new by talking rather than reading about it. .... SD D U A SA
34. At home I usually study under a shaded lamp while the rest of the room is dim. .... SD D U A SA
35. I really like to do experiments. .... SD D U A SA
36. I usually feel more comfortable in cool weather than I do in warm weather. .... SD D U A SA
37. When I do well in school, grown-ups in my family are proud of me. .... SD D U A SA
38. It is hard for me to be motivated to do my school work. .... SD D U A SA
39. I think best when I feel cool. .... SD D U A SA
40. I like to relax on rugs, carpets, a couch, a soft chair, or a bed when I study. .... SD D U A SA
41. It is important for me to please my teacher when I do my school work. .... SD D U A SA
42. I remember to do what I am told. .... SD D U A SA
43. I learn better by reading than by talking. .... SD D U A SA
44. Background noises or sound does not bother me when I do my school work. .... SD D U A SA

OVER

45. I am happy when I get good grades. SD D U A SA
46. I like to learn most by building, making or doing things. SD D U A SA
47. I usually finish my homework. SD D U A SA
48. If I could go to school anytime during the day, I would choose to go in the early morning. SD D U A SA
49. I have to be reminded several times to do my school work. SD D U A SA
50. It is harder for me to get things done in the late morning compared to the afternoon. SD D U A SA
51. It is easy for me to remember what I learn when I feel it inside me. SD D U A SA
52. I like to be told exactly what to do. SD D U A SA
53. My parents are interested in how I do in school. SD D U A SA
54. I like my teacher to check my school work. SD D U A SA
55. I enjoy learning by going places. SD D U A SA
56. When I really have a lot of studying to do I like to work alone. SD D U A SA
57. Sometimes I like to learn alone, sometimes with a friend, or sometimes with an adult. SD D U A SA
58. I can sit in one place for a long time. SD D U A SA
59. I cannot get interested in my school work. SD D U A SA
60. I really like to draw, color, or trace things. SD D U A SA
61. I remember the things I hear better than when I read about them. SD D U A SA
62. I remember things best when I study them in the afternoon. SD D U A SA
63. No one really cares if I do well in school. SD D U A SA
64. I really like to shape and make things with my hands. SD D U A SA
65. When I study I like lots of bright light. SD D U A SA
66. I like to eat, drink, or chew on something while I study. SD D U A SA
67. When I really have a lot of studying to do I like to work with a group of friends. SD D U A SA
68. When it's warm outside I like to go out. SD D U A SA
69. I remember things best when I study them early in the morning. SD D U A SA
70. I can sit in one place for a long time. SD D U A SA
71. I often forget to do or finish my homework. SD D U A SA
72. I like to make things with my hands as I learn. SD D U A SA
73. I can think best in the evening. SD D U A SA
74. I like to be told how and what to do before I begin my homework. SD D U A SA
75. I am most awake around 10:00 in the morning. SD D U A SA
76. The things I like doing best in school I do with friends. SD D U A SA
77. I like adults nearby when I study. SD D U A SA
78. My family wants me to get good grades. SD D U A SA
79. Late morning is the best time for me to study. SD D U A SA
80. I like to learn most by building, making or doing things. SD D U A SA
81. I often want to start something new rather than finish what I've started. SD D U A SA
82. I keep forgetting to do the things I've been told to do. SD D U A SA
83. I like to be able to move and experience the motion and the feel of what I study. SD D U A SA
84. When I really have a lot of studying to do I like to work with two friends. SD D U A SA
85. I like to learn through real experiences. SD D U A SA
86. If I could go to school anytime during the day, I would choose to go in the early morning. SD D U A SA
87. I like to have an adult nearby when I do my school work. SD D U A SA
88. I can block out most sound when I study. SD D U A SA
89. If I have something new to learn, I would rather read than talk with someone to learn about it. SD D U A SA
90. I study best around 10:00 in the morning. SD D U A SA
91. I like school most of the time. SD D U A SA
92. I remember things better when people tell them to me rather than when I read about them. SD D U A SA
93. I often eat something while I study. SD D U A SA
94. I enjoy being with friends when I study. SD D U A SA
95. It's hard for me to sit in one place for a long time. SD D U A SA
96. I remember things best when I study them before evening. SD D U A SA
97. I think my teacher wants me to get good grades. SD D U A SA
98. I like to do things with adults. SD D U A SA
99. I really like to build things. SD D U A SA
100. I can study best in the afternoon. SD D U A SA
101. Sound bothers me when I am studying. SD D U A SA
102. When I really have a lot of studying to do I like to study with friends. SD D U A SA
103. When I can, I do my homework in the afternoon. SD D U A SA
104. I love to learn new things. SD D U A SA

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DESCRIPTION OF THE AREAS

1. **NOISE LEVEL** – Quiet or Sound. Some people need quiet when they are learning, while others notice neither noise nor movement once they begin to concentrate; they can "block out" sound. Some people need sound; they invariably turn on a radio, stereo or television whenever they study as a screen against random noise distractions. A profile score of 60 or higher indicates a preference for sound.

2. **LIGHT** – Low or Bright. Some people work best under very bright light whereas others need dim, indirect or low light. A profile score of 60 or higher indicates a preference for bright light.

3. **TEMPERATURE** – Cool or Warm. Many students can't "think" when they feel hot, and others can't "think" when they feel cold; some concentrate better in either a warm or cool environment. A profile score of 60 or higher indicates a preference for warm temperatures.

4. **DESIGN** – Informal or Formal. Many students think best in a formal environment seated on wooden, steel, or plastic chairs like those found in conventional classrooms, a library, or a kitchen. However, some learn better in an informal environment, on a lounge chair, a bed, the floor, pillows, or on carpeting.

5. **UNMOTIVATED/SELF-MOTIVATED** – Self-motivation is the desire to achieve academically, to please oneself.

6. **NOT PERSISTENT/PERSISTENT** – This element involves a person's inclination either to complete tasks that are begun or to take intermittent "breaks" and return to assignments or learning activities later.

7. **NOT RESPONSIBLE/RESPONSIBLE** – This element involves students' desire to do what they think they ought to do. In schools, responsibility often is related to conformity or following through on what a teacher asks students to do. Students with low responsibility scores usually are nonconforming; they do not like to do something because someone asks them to.

8. **STRUCTURE** – Wants or Does Not Want Structure. This element involves a student's preference for specific directions or explanations prior to undertaking or completing an assignment versus the student's preference for doing an assignment his/her way.

9. **LEARNING ALONE/PEER-ORIENTED LEARNER** – Some individuals prefer to study alone while others prefer to learn with a friend or colleague; in the latter situation, discussion and interaction facilitate learning. Sometimes students prefer to study alone but in close proximity to others. The factor analysis does not differentiate among those individuals who want to learn with just one other person or with several individuals.

10. **AUTHORITY FIGURES PRESENT** – Some people feel better or more comfortable when someone with authority or recognized special knowledge is present.

11. **PREFERS LEARNING IN SEVERAL WAYS** – This element has alternate meanings. The element suggests that the person may learn easily alone and also with other people present (with peers, with an authority, or in any combination) or that the person needs variety, as opposed to routines.

12. **AUDITORY PREFERENCES** – This perceptual area describes people who can learn best when initially listening to verbal instruction such as a lecture, discussion, or recording.

13. **VISUAL PREFERENCES** – A learner whose primary perceptual strength is visual can recall what has been read or observed. When these learners are asked for information from printed or diagrammatic material, they can close their eyes and visually recall what they have read or seen earlier.

14. **TACTILE PREFERENCES** – Students with tactile perceptual strengths need to underline as they read, take notes when they listen and keep their hands busy particularly if they also have low auditory ability.

15. **KINESTHETIC PREFERENCES** – Learners with kinesthetic preferences require whole-body movement and/or real-life experiences to absorb and retain material to be learned. These learners learn most easily when they are totally involved. Acting, puppetry, and drama are excellent examples of kinesthetic learning; other examples include building, designing, interviewing, and role-playing.

16. **REQUIRES INTAKE** – This area describes those students who often eat, drink, chew, or bite objects while concentrating as opposed to those who prefer no intake until after they have finished studying.

17. **FUNCTIONS BEST IN EVENING/MORNING** – These are two of the four "time-of-day preferences." Evening and Morning are on a continuum; if a score falls below 40, the student tends to be an evening person; if the score is above 60, the student prefers to learn in the early morning.

18. **FUNCTIONS BEST IN LATE MORNING** – The energy curve for these students is highest in the late morning (around 10:00 a.m.) and they prefer to learn during the late morning.

19. **FUNCTIONS BEST IN AFTERNOON** – The energy curve for these students is highest in the afternoon and they prefer to learn during the afternoon.

20. **MOBILITY** – How still can the person sit and for how long? Some people need frequent "breaks" and must move around the instructional environment. Others can sit for hours while engaged in learning particularly if they are interested in the task.

21. **PARENT FIGURE MOTIVATED** – These students want to achieve to please parents or parent figures. They often complete tasks because a family member will be proud of their accomplishments.

22. **TEACHER MOTIVATED** – These students want to learn and complete assignments because their teachers will be pleased with their efforts.

APPENDIX B

Productivity Environment Preference Survey

PRODUCTIVITY ENVIRONMENTAL PREFERENCE SURVEY Dunn, Dunn and Price

PRINT INSIDE BOXED IN AREA ONLY

FORM #8

Major or Occupation

Read each statement and decide to what extent you would agree or disagree with that statement if you had something new or difficult to learn. Mark (SD), if you strongly disagree, or (D), disagree, or (U), uncertain, or (A), agree, or (SA), strongly agree, as the response that best describes how you feel most of the time. Give your immediate or first reaction to each question. Please answer all the questions on both sides of form.

1. I prefer working in bright light. (SD) (D) (U) (A) (SA)
2. I like to work alone. (SD) (D) (U) (A) (SA)
3. It is easy for me to concentrate late at night. (SD) (D) (U) (A) (SA)
4. I like to draw or use diagrams when I work. (SD) (D) (U) (A) (SA)
5. I often have to be reminded to complete certain tasks or assignments. (SD) (D) (U) (A) (SA)
6. The one job I like doing best, I like to do with an expert in the field. (SD) (D) (U) (A) (SA)
7. I can think better lying down than sitting. (SD) (D) (U) (A) (SA)
8. I prefer cool temperatures when I need to concentrate. (SD) (D) (U) (A) (SA)
9. I like to block out noise or sound when I work. (SD) (D) (U) (A) (SA)
10. People keep reminding me to complete my work. (SD) (D) (U) (A) (SA)
11. It is difficult for me to concentrate when I am warm. (SD) (D) (U) (A) (SA)
12. The one job I like doing best, I do with two or more people. (SD) (D) (U) (A) (SA)
13. I prefer to work or read where the lights are shaded. (SD) (D) (U) (A) (SA)
14. When I concentrate I like to sit on a soft chair or couch. (SD) (D) (U) (A) (SA)
15. I usually finish what I start. (SD) (D) (U) (A) (SA)
16. The things I remember best are the things that I hear. (SD) (D) (U) (A) (SA)
17. I enjoy tasks that allow me to take breaks. (SD) (D) (U) (A) (SA)
18. I can work more effectively in the afternoon than in the morning. (SD) (D) (U) (A) (SA)
19. I like to "snack" when I'm concentrating. (SD) (D) (U) (A) (SA)
20. When I have a lot of work to do I like to work with several colleagues. (SD) (D) (U) (A) (SA)
21. Noise or extraneous sound usually keeps me from concentrating. (SD) (D) (U) (A) (SA)
22. I often forget to do the things I've said I would do. (SD) (D) (U) (A) (SA)
23. I take lots of notes in a lecture, to help me remember. (SD) (D) (U) (A) (SA)
24. I like to work or analyze an assignment with another individual. (SD) (D) (U) (A) (SA)
25. I prefer cool temperatures when I'm working. (SD) (D) (U) (A) (SA)
26. The one job I like doing best, I do with several people. (SD) (D) (U) (A) (SA)
27. I concentrate best in the late afternoon. (SD) (D) (U) (A) (SA)
28. The things I remember best are the things that I read. (SD) (D) (U) (A) (SA)
29. I usually complete tasks that I start. (SD) (D) (U) (A) (SA)
30. I can concentrate better when I sit up rather than when I recline. (SD) (D) (U) (A) (SA)
31. I like to learn or work with a person in authority. (SD) (D) (U) (A) (SA)
32. I work best early in the morning. (SD) (D) (U) (A) (SA)
33. I get a lot done when I work on my own. (SD) (D) (U) (A) (SA)
34. When I work I turn all the lights on. (SD) (D) (U) (A) (SA)
35. I prefer that others share responsibility for a task we're doing. (SD) (D) (U) (A) (SA)
36. I really enjoy television. (SD) (D) (U) (A) (SA)
37. I like either a teacher or supervisor to outline tasks I have to complete. (SD) (D) (U) (A) (SA)
38. I like to sit on a straight-back chair when I concentrate. (SD) (D) (U) (A) (SA)
39. I work or study best by myself. (SD) (D) (U) (A) (SA)
40. I can remember things best when I study them in the evening. (SD) (D) (U) (A) (SA)
41. I remember best the things I read in a book or magazine. (SD) (D) (U) (A) (SA)
42. I always finish tasks that I start. (SD) (D) (U) (A) (SA)
43. If I have to learn something new, I prefer to learn about it by hearing a record, tape or lecture. (SD) (D) (U) (A) (SA)
44. I am most alert in the evening. (SD) (D) (U) (A) (SA)

45. The one job I like doing best, I do with a group of people. .... SD D U A SA
46. I am uncomfortable when I work or try to study in a warm room. .... SD D U A SA
47. I prefer to have teachers or supervisors set deadlines for my work. .... SD D U A SA
48. I like to eat while I'm concentrating. .... SD D U A SA
49. I prefer completing one thing before I start something else. .... SD D U A SA
50. It is difficult for me to start a new task before I finish the task I am doing. .... SD D U A SA
51. I really enjoy movies. .... SD D U A SA
52. I have to be reminded to do things I've said I would do. .... SD D U A SA
53. I work best when the lights are shaded. .... SD D U A SA
54. I prefer that persons in authority stay away until I have completed my work. .... SD D U A SA
55. I keep trying to accomplish a task even if it appears that I may not succeed. .... SD D U A SA
56. I like to learn about something new by hearing a tape or a lecture. .... SD D U A SA
57. I feel I am self-motivated. .... SD D U A SA
58. The one job I like doing best, I prefer doing alone. .... SD D U A SA
59. Eating something would distract me when I'm working. .... SD D U A SA
60. My performance improves if I know my work will be checked. .... SD D U A SA
61. I prefer to work with music playing. .... SD D U A SA
62. I stay at a task until it is finished, even if I don't like what has to be done. .... SD D U A SA
63. I learn best by being directly involved in what I am doing. .... SD D U A SA
64. I always do the best I can. .... SD D U A SA
65. I prefer to learn how to do a new task by actually doing it. .... SD D U A SA
66. I often read in dim light. .... SD D U A SA
67. If I have to learn something new, I like to learn about it by reading. .... SD D U A SA
68. I prefer someone else carefully outline how a task should be done. .... SD D U A SA
69. I would rather start work in the morning than in the evening. .... SD D U A SA
70. I constantly change positions in my chair. .... SD D U A SA
71. The things I remember best are the things that I hear. .... SD D U A SA
72. I like my instructor(s) or supervisor(s) to recognize my efforts. .... SD D U A SA
73. I learn better by reading than by listening to someone. .... SD D U A SA
74. I get more done in the afternoon than in the morning. .... SD D U A SA
75. I can block out most sound when I work. .... SD D U A SA
76. I really like to build things. .... SD D U A SA
77. I prefer to work under a shaded lamp with the rest of the room dim. .... SD D U A SA
78. I choose to eat, drink or chew only after I finish working. .... SD D U A SA
79. I remember things better when I study in the evening. .... SD D U A SA
80. If I have to learn something new, I like to learn about it by seeing a movie. .... SD D U A SA
81. I feel good when my spouse, colleague or supervisor praises me for doing well at my job. .... SD D U A SA
82. I prefer a cool environment when I try to study. .... SD D U A SA
83. It's difficult for me to block out sound (music, T.V., talking) when I work. .... SD D U A SA
84. I would rather learn by experience than by reading. .... SD D U A SA
85. I like being praised for a "job well done." .... SD D U A SA
86. It's difficult for me to sit in one place for a long time. .... SD D U A SA
87. I like to have something to drink when I work. .... SD D U A SA
88. I enjoy doing experiments. .... SD D U A SA
89. If a task becomes very difficult, I tend to lose interest in it. .... SD D U A SA
90. I like to learn new things. .... SD D U A SA
91. I can sit in one place for a long time. .... SD D U A SA
92. I can concentrate best in the evening. .... SD D U A SA
93. I prefer to study with someone who really knows the material. .... SD D U A SA
94. I often change my position when I work. .... SD D U A SA
95. I would work more effectively if I could eat while I'm working. .... SD D U A SA
96. If I can go through each step of a task, I always remember what I learn. .... SD D U A SA
97. I learn better when I read the instructions than when someone tells me what to do. .... SD D U A SA
98. I only begin to feel wide awake after 10:00 A.M. .... SD D U A SA
99. I often complete unfinished work on a bed or couch where I can recline. .... SD D U A SA
100. I often wear a sweater or jacket indoors. .... SD D U A SA

STOP

APPENDIX C

Narrative Report: Individual Profile

Narrative Report for the
Productivity Environmental Preference Survey
Individual Profile

Name: PERINE DONALD
Date: 7/16/01
Group Identification: MTSU C

Year of Birth: 54
Grade: 13
Identification:

Group Number: 539
Sex: Male
Special Code: 000012

Preference Summary

20 30 40 50 60 70 80

Scale	Standard Score			
1	56	Prefers Quiet	NOISE LEVEL *	Prefers Sound
2	56	Prefers Dim	LIGHT *	Prefers Bright
3	43	Prefers Cool	* TEMPERATURE	Prefers Warm
4	41	Prefers Informal	* DESIGN	Prefers Formal
5	52	Low	MOTIVAT*ON	High
6	56	Low	PERSISTENT *	High
7	54	Low	RESPONSIBLE(CONF*RMING)	High
8	64	Does Not Like	STRUCTURE	* High
9	69	Prefers Alone	ALONE/PEERS	Prefer* With Peers
10	63	Does Not Want Present	AUTHORITY FIGURES	* Wants Present
11	34	Does Not Learn*	SEVERAL WAYS	Prefers Variety
12	55	Does Not Prefer	AUDITORY *	Prefers
13	46	Does Not Prefer	* VISUAL	Prefers
14	57	Does Not Prefer	TACTILE *	Prefers
15	55	Does Not Prefer	KINESTHETIC *	Prefers
16	56	Does Not Prefer	INTAKE *	Prefers
17	36	Prefers Evening *	TIME OF DAY	Prefers Morning
18	45	Does Not Prefer	*ATE MORNING	Prefers
19	67	Does Not Prefer	AFTERNOON	* Prefers
20	53	Does Not Prefer	NEEDS MOBI*ITY	Prefers

Profile Number: 13

Narrative Report for the
Productivity Environmental Preference Survey

Name: PERJNE DONALD Date: 7/16/01 Page: 2

The Productivity Style Computerized Interpretive Report will help you understand the Learning Style model by Dunn, Dunn, & Price and explain the areas on your profile. Your Report is based on your responses to questions about the kind of environment and methods you prefer when learning new or difficult material and working. Important--this is a description of how you like to learn and work; it is not an evaluation of your productivity styles.

Good or bad productivity styles do not exist. From our research, we know that people prefer to work and learn differently. Once you identify your preference, you can be more productive and learn more easily and successfully.

The first thing you should do with your Report is to check the consistency score (not on the adult printout), which is on the lower left-hand side of the profile. This consistency score should be 70 or higher. It is based on your responses to the questions on the Inventory. A low consistency score indicates one of several things, each of which could make your profile invalid. If you answered on a bubble sheet you may not have used the correct pencil and your responses were not dark enough. Maybe you answered without reading the questions carefully. A score of 70 or higher indicates that you were careful in reading and responding to the questions and that your Report validly reflects your learning style.

At the top of the profile is your name, an identification number (if entered), year of birth, grade and your sex are printed. The date is the date the report was printed.

The row of scores on the left of your profile represents your responses totaled in each area and compared to the national data base to calculate a standard score (t-score) in each area. This shows your position compared to others in your age group for each of the areas.

On the left side of the profile is an area for T-scores forty or below, and on the right side is an area for T-scores sixty or higher. The area between 40 and 60 indicates scores that are neither high nor low for you. Forty or below and sixty or above means that area is an important

Narrative Report for the
Productivity Environmental Preference Survey

Name: PERINE DONALD Date: 7/16/01 Page: 3

preference for you.

Your preference pattern is represented by asterisks (#) across the profile form (from 0-80 T-Score). If your '#' is in the middle (between 40 and 60 T-Score), your preference 'depends' on other factors - sometimes this area is important to you, and other times it is not. It may depend on the material you are producing, the environment in which you are producing, or who you are with when you are being productive.

To interpret your profile, you should review each of the areas to identify what is important to you. If your score is 60 or higher or 40 or lower in an area, you should consider the recommendations printed in your Report. Research has shown that if people use the learning style information, they will be more productive and more successful. In addition, they will be happier when they work or learn.

Remember, there is nothing good or bad about any of the scores on your profile. They just describe the kind of environment in which you prefer to work or learn. Like your fingerprints, everyone has a unique style, and it is important for you to know what your style is. This information can help you understand yourself and others better.

The following Report is based on your individual responses regarding your individual learning and productivity style:

AREA 8 - STRUCTURE - 60 Or Higher

You want your supervisor or teacher to give you a lot of detail as to how he/she wants the task completed. You want to know the specific details for each of your tasks and/or assignments. You want a lot of direction before you work on assignments or tasks.

AREA 9 - ALONE / PEER - 60 Or Higher

You like to study or work with others. You are more productive working with others than by yourself. Talking with others about the tasks helps you understand and learn.

Narrative Report for the
Productivity Environmental Preference Survey

Name: PERINE DONALD Date: 7/16/01 Page: 4

AREA 10 - AUTHORITY FIGURES PRESENT - 60 Or Higher

You like to have an authority figure - a supervisor or an adult you can look up to or respect - in the room or nearby while you are working or studying.

AREA 11 - SEVERAL WAYS - 40 Or Below

The way you like to learn or work is more specific. Sometimes you like to produce by yourself and sometimes you prefer to work or learn with others. Try to interpret this in terms of other areas on your profile to determine whether you prefer to learn by yourself, with peers or with authority figures present.

AREA 17 - EVENING / MORNING - 40 Or Below

You are not most productive in the morning. It may take you a long time to wake up in the morning. You concentrate best in the evening. It is important to schedule your most difficult tasks during your most productive time in the evening.

AREA 19 - AFTERNOON - 60 Or Higher

You are most productive and learn best during the afternoon. You should work, study and do your difficult projects during the afternoon.

This computerized interpretive Report is based on your responses to the inventory. It helped you understand areas on the profile. It is important for you to understand that everyone learns differently. Some people prefer to produce like you in some areas, but few people are the same in every area. The closer your environment meets your needs and preferences, the happier you will be in your work and learning.

Sometimes, if you are motivated, you can produce in ways other than how you prefer. If you are an auditory learner, sometimes you can learn by reading or looking at things on the board. If you are a visual learner, you could force yourself to learn by listening to someone. Some supervisors and teachers may not understand how you work or learn. In this case, you may have to

Narrative Report for the
Productivity Environmental Preference Survey

Name: PERINE DONALD Date: 7/16/01 Page: 5

adapt yourself to their style. You have to be responsible and be productive even if that person is not supporting you in your preferred productive style.

It would be helpful if you could talk with your teacher or your supervisor about how you work and learn, show them your profile and talk about what this means to you. Many times teachers and supervisors are frustrated because they want you to be productive, but they don't know how to help you. Going over this profile with them will help them better understand you as an individual.

If you have questions about your profile, or if you have other questions, write us at the following address: Price Systems, Inc., PO Box 1818, Lawrence, KS 66044. Write us, too, if you want to know where to get materials to help you better understand your productive style. Many supervisors and instructors believe in learning styles and are trying to help people learn by developing materials and allowing individuals to meet their needs. If you have found some special ways that help you be more effective please let us know about them.

Good luck as you work and learn. We hope this is helpful to you as you develop 'in style'.

APPENDIX D

Reprinted
from
LSI Manual
by
Gary E. Price, Ph.D.
Rita Dunn, Ed.D.

Price Systems, Inc.,Lawrence, KS

Meta-Analysis of Learning Styles

This investigation (Sullivan, 1993) was a quantitative synthesis of 42 experimental research studies with a sample size of 3,434 students, based on the Dunn, Dunn, & Price Learning Style Model. A meta-analytic approach was utilized to determine whether identifying learning style preferences as a basis for responsive instruction led to academic improvement and whether moderators influenced the outcome. A quality-rating scale based on internal and external validity was employed to evaluate the studies and resulted in a Total Set and a Quality Set of studies. The Total Set attained an unweighted population mean of .34191 and a weighted population mean of .35336. The Quality Set attained an unweighted population mean of .38109 and a weighted population mean of .35336. These average effect size r's achieved a medium magnitude of effect size. With significance at .01, statistical power was attained beyond .995. Moreover, these effect size values were educationally significant (attaining .33000), that point at which the incorporation of a treatment is of practical benefit in the teaching and learning process. The mean standardized difference for the Total Set was .72243. The mean standardized difference for the Quality Set of .75546 indicated that when learning styles are matched with congruous instruction, improvement could be expected to increase by 75% of a standard deviation of the normal curve distribution. Variables showed a mediating influence on the interaction of matching learning style preferences to complementary treatment and improvement. These moderators included research factors (research chronology); instrument factors (stimuli of the model, degree of preference and attitude scale); subject factors (sample size); setting factors (school type, school level, academic level and socioeconomic level); instructional factors (subject area, treatment time, and test material); and methodological factors (experimental design). The outstanding subset was the average academic level of students with the largest unweighted and weighted effect sizes. This meta-analysis revealed consistent effects of treatment across mediators and demonstrated that matching learning style preferences to appropriate instructional treatment augmented learning outcomes. An additional finding was that as the degree of learning style preferences increased the effect size and mean standardized difference also increased giving support to the position that learning styles may be learning style strengths.

APPENDIX E

Reprinted
from
LSI Manual
by
Gary E. Price, Ph.D.
Rita Dunn, Ed.D.

Price Systems, Inc.,Lawrence, KS

LSI Manual

Reliabilities and Standard Errors for LSI
1996 Likert Scale in English, N=817, Grades 5-12

Area	Reliability*	Standard Error
Noise Level	0.86	1.73
Light	0.80	1.45
Temperature	0.75	1.71
Design	0.75	1.47
Motivation	0.77	2.28
Persistent	0.81	1.76
Responsible	0.82	1.38
Structure	0.69	1.58
Learn Alone	0.88	2.29
Authority Figure	0.70	1.57
Several Ways	0.72	1.48
Auditory	0.75	1.50
Visual	0.73	1.27
Tactile	0.77	1.87
Kinesthetic	0.71	2.16
Requires Intake	0.86	1.43
Evening Morning	0.79	1.81
Late Morning	0.56	1.74
Afternoon	0.66	1.81
Need mobility	0.88	1.32
Parent Motivated	0.76	1.30
Teacher Motivated	0.76	1.31

*Hoyt's Reliability (equivalent to a KR-20

APPENDIX F

Reprinted
from
PEPS Manual
by
Gary E. Price, Ph.D.
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Price Systems, Inc., Lawrence, KS

Reliabilities for PEPS, N=504, 1/8/96

Area	**Reliability (r)**
Noise Level	0.86
Light	0.91
Temperature	0.86
Design	0.76
Motivation	0.65
Persistent	0.63
Responsible	0.76
Structure	0.71
Learn Alone	0.86
Authority Figure	0.48
Several Ways	0.67
Auditory	0.81
Visual	0.71
Tactile	0.33
Kinesthetic	0.67
Requires Intake	0.88
Evening Morning	0.87
Late Morning	0.84
Afternoon	0.88
Need mobility	0.83

APPENDIX G

Reprinted
from
TOSRA HANDBOOK
by
Barry J. Fraser
Macquaire University
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Australian Council for Educational Research

Table 1 Name and Classification of Each Scale in TOSRA

Scale name	Klopfer (1971) classification	
Social Implications of Science (S) Normality of Scientists (N)	H.1:	Manifestation of favourable attitudes towards science and scientists
Attitude to Scientific Inquiry (I)	H.2:	Acceptance of scientific inquiry as a way of thought
Adoption of Scientific Attitudes (A)	H.3:	Adoption of 'scientific attitudes'
Enjoyment of Science Lessons (E)	H.4:	Enjoyment of science learning experiences
Leisure Interest in Science (L)	H.5:	Development of interest in science and science-related activities
Career Interest in Science (C)	H.6:	Development of interest in pursuing a career in science

Table 2 Sample Sizes for Years 7–10

Year	Number of classes[a]	Number of students
7	11	340
8	11	335
9	11	338
10	11	324
Total	44	1337

[a] One class at each level was drawn from a different school.

Means

Table 3 shows, separately for each level, the mean score on each of the seven TOSRA scales and the overall mean of the seven scale means. The possible score range on each scale is from a minimum of 10 to a maximum of 50. The results in Table 3 indicate that the mean score on each scale tended to be approximately similar at all four levels, although the mean score did tend to vary considerably from scale to scale. In fact, for the Year 7 sample, mean scores ranged from 27.5 for the Leisure Interest in Science scale to 40.5 for the Attitude to Inquiry scale.

Standard Deviations

The standard deviation of each scale and the mean of the seven scale standard deviations are shown separately for each level in Table 3. These values indicate that TOSRA scales generally had a reasonable spread of scores at each level. The table also shows that the standard deviation for a given scale was comparable at each level, although the standard deviation varied considerably from scale to scale (ranging from 4.5 for the Adoption of Scientific Attitudes scale to 9.5 for the Enjoyment of Science Lessons scale at the Year 7 level).

Reliability

The internal consistency reliability (the extent to which items in a given scale measure the same attitude) was estimated for TOSRA scales using the Cronbach α coefficient (Cronbach, 1951). Table 3 shows, separately for each level, the α coefficient for each TOSRA scale and the mean of the seven scale coefficients. The values of the α reliability coefficient ranged from 0.66 to 0.93 with a mean of 0.82 for the Year 7 sample, from 0.64 to 0.93 with a mean of 0.80 for the Year 8 sample, from 0.69 to 0.92 with a mean of 0.81 for the Year 9 sample, and from 0.67 to 0.93 with a mean of 0.84 for the Year 10 sample. These values for the reliability coefficient are generally high for scales whose length is only 10 items, and all values are large enough to indicate that each TOSRA scale had quite good internal consistency reliability at each level.

In addition to internal consistency reliability coefficients, Table 3 contains estimates of the test-retest reliability of TOSRA scales. These calculations were based on data from a sub-sample of 238 students comprising the Year 8 and Year 9 classes in four of the schools (two coeducational government high schools, one independent Catholic girls school and one independent non-Catholic boys school) in the original sample. These students responded to TOSRA a second time approximately two weeks after the first administration. Table 3 shows that test-retest coefficients ranged from 0.69 to 0.84 with a mean of 0.78, thus indicating that all TOSRA scales displayed quite good test-retest reliability.

Discriminant Validity

Intercorrelations among TOSRA scales were calculated as indices of discriminant validity (the extent to which a given scale measures a unique attitude not measured by other scales in the battery). It was found that, for the total sample of 1337 students, TOSRA scale intercorrelations were generally fairly low and ranged from 0.10 to 0.59 with a mean of 0.33. The average correlation of each TOSRA scale with the other six scales was calculated and these values are recorded in Table 3. The table shows that the mean correlation of a given scale with the other six scales had moderately low values ranging from 0.13 for the Attitude to Inquiry scale to 0.40 for the Career Interest in Science scale.

It is noteworthy that the highest scale intercorrelations (values of 0.53, 0.58 and 0.59) occurred between the three scales of Enjoyment of Science Lessons, Leisure Interest in Science and Career Interest in Science. Although these three attitudes are conceptually distinct, one would generally expect them to be moderately well correlated among students since there would be a tendency for a student who enjoys science lessons to be more likely to have a leisure and career interest in science. Furthermore, as all values of the scale intercorrelation were smaller than the square root of the product of the corresponding scale reliabilities, which is the value representing perfect conceptual equivalence (Block, 1963), it was considered justifiable to maintain all seven TOSRA scales as separate dimensions.

Table 3 Mean, Standard Deviation, Reliability and Discriminant Validity (Mean Correlation with Other Scales) of Each TOSRA Scale

Scale	Mean in Year				Standard deviation in Year				α Reliability in Year				Test-retest reliability[a]	Mean correlation with other scales
	7	8	9	10	7	8	9	10	7	8	9	10		
Social Implications of Science	35.7	34.2	35.9	37.3	5.7	6.2	4.9	5.2	0.81	0.82	0.75	0.82	0.76	0.39
Normality of Scientists	35.6	34.3	35.8	36.3	5.2	5.1	4.9	4.9	0.72	0.70	0.72	0.78	0.69	0.27
Attitude to Inquiry	40.5	39.3	38.2	35.9	5.8	6.2	5.9	6.7	0.81	0.82	0.81	0.86	0.79	0.13
Adoption of Scientific Attitudes	38.0	37.2	37.9	38.4	4.5	4.5	4.5	4.2	0.66	0.64	0.69	0.67	0.75	0.33
Enjoyment of Science Lessons	32.8	29.7	31.2	33.5	9.5	9.6	8.9	8.6	0.93	0.92	0.92	0.93	0.78	0.39
Leisure Interest in Science	27.5	24.7	24.9	26.9	8.6	8.3	8.0	8.4	0.88	0.85	0.87	0.89	0.82	0.39
Career Interest in Science	28.2	26.0	26.5	28.8	8.2	8.2	7.8	8.4	0.90	0.88	0.88	0.91	0.84	0.40
Mean of nine scales	34.0	32.2	32.9	33.9	6.8	6.9	6.4	6.6	0.82	0.80	0.81	0.84	0.78	0.33

Each scale contains 10 items scored from 1 to 5 so that the minimum and maximum score possible on each scale is 10 and 50 respectively.

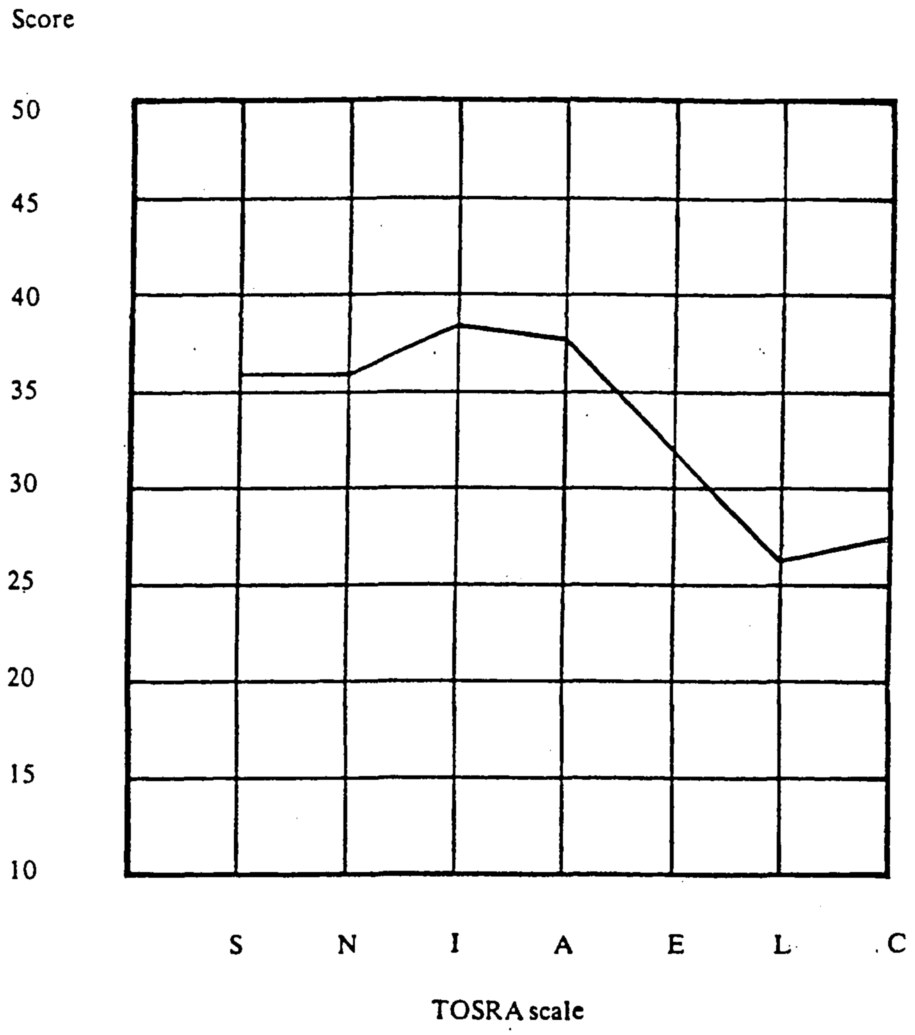
The sample sizes at different levels ranged from 324 to 340.

α Test-retest coefficients were estimated for a sub-sample of 238 students from Years 8 and 9, drawn from the original sample.

Table 4 Cross-Validation Data from Australia and United States

	Alpha reliability					Mean correlation with other scales	
Scale	NSW Years 7–10 (N=712)	Qld Year 10 (N=567)	Qld Year 12 (N=273)	WA Years 8–10 (N=1041)	US Year 9 (N=546)	NSW Years 7–10 (N=712)	US Year 9 (N=546)
Social Implications of Science	0.80	0.81	0.81	0.81	0.76	0.37	0.38
Normality of Scientists	0.71	0.69	0.71	0.73	0.63	0.23	0.23
Attitude to Inquiry	0.81	0.82	0.83	0.69	0.84	0.25	0.29
Adoption of Scientific Attitudes	0.62	0.64	0.67	0.68	0.64	0.38	0.36
Enjoyment of Science Lessons	0.91	0.90	0.90	0.91	0.92	0.43	0.34
Leisure Interest in Science	0.86	0.84	0.87	0.87	0.86	0.38	0.38
Career Interest in Science	0.88	0.85	0.88	0.88	0.87	0.40	0.42

Figure 1 Profile of Mean Scores Obtained on Each TOSRA Scale by the Field Testing Sample



TOSRA

TEST OF SCIENCE-RELATED ATTITUDES

Barry J. Fraser

DIRECTIONS

1 This test contains a number of statements about science. You will be asked what you yourself think about these statements. There are no 'right' or 'wrong' answers. Your opinion is what is wanted.

2 All answers should be given on the separate Answer Sheet. Please do not write on this booklet.

3 For each statement, draw a circle around

SA	if you STRONGLY AGREE with the statement;
A	if you AGREE with the statement;
N	if you are NOT SURE;
D	if you DISAGREE with the statement;
SD	if you STRONGLY DISAGREE with the statement.

Practice Item

0 It would be interesting to learn about boats.

Suppose that you AGREE with this statement, then you would circle A on your Answer Sheet, like this:

0 SA [✓ A] N D SD

4 If you change your mind about an answer, cross it out and circle another one.

5 Although some statements in this test are fairly similar to other statements, you are asked to indicate your opinion about all statements.

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Australian Council for Educational Research

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1. Money spent on science is well worth spending.
2. Scientists usually like to go to their laboratories when they have a day off.
3. I would prefer to find out why something happened by doing an experiment than by being told.
4. I enjoy reading about things, which disagree with my previous ideas.
5. Science lessons are fun.
6. I would like to belong to a science club.
7. I would dislike being a scientist after I leave school.
8. Science is man's worst enemy.
9. Scientists are about as fit and healthy as other people.
10. Doing experiments is not as good as finding out information from teachers.
11. I dislike repeating experiments to check that I get the same results.
12. I dislike science lessons.
13. I get bored when watching science programs on TV at home.
14. When I leave school, I would like to work with people who make science discoveries.
15. Public money spent on science in the last few years has been used wisely.
16. Scientists do not have enough time to spend with their families.
17. I would prefer to do experiments than to read about them.
18. I am curious about the world in which we live.
19. School should have more science lessons each week.
20. I would like to be given a science book or a piece of scientific equipment as a present.
21. I would dislike a job in a science laboratory after I leave school.
22. Scientific discoveries are doing more harm than good.
23. Scientists like sport as much as other people do.
24. I would rather agree with other people than do an experiment to find out for myself.
25. Finding out about new things is unimportant.
26. Science lessons bore me.
27. I dislike reading books about science during my holidays.
28. Working in a science laboratory would be an interesting way to earn a living.

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29. The government should spend more money on scientific research.
30. Scientists are less friendly than other people.
31. I would prefer to do my own experiments than to find out information from a teacher.
32. I like to listen to people whose opinions are different from mine.
33. Science is one of the most interesting subjects at school.
34. I would like to do science experiments at home.
35. A career in science would be dull and boring.
36. Too many laboratories are being built at the expense of the rest of education.
37. Scientists can have a normal family life.
38. I would rather find out about things by asking an expert than by doing an experiment.
39. I find it boring to hear about new ideas.
40. Science lessons are a waste of time.
41. Talking to friends about science after school would be boring.
42. I would like to teach science when I leave school.
43. Science helps to make life better.
44. Scientists do not care about their working conditions.
45. I would rather solve a problem by doing an experiment than be told the answer.
46. In science experiments, I like to use new methods, which I have not used before.
47. I really enjoy going to science lessons.
48. I would enjoy having a job in a science laboratory during my school holidays.
49. A job as a scientist would be boring.
50. This country is spending too much money on science.
51. Scientists are just as interested in art and music as other people are.
52. It is better to ask the teacher the answer than to find it out by doing experiments.
53. I am unwilling to change my ideas when evidence shows that the ideas are poor.
54. The material covered in science lessons is uninteresting.
55. Listening to talk about science on the radio would be boring.
56. A job as a scientist would be interesting.

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57. Science can help to make the world a better place in the future.
58. Few scientists are happily married.
59. I would prefer to do an experiment on a topic than to read about it in science magazines.
60. In science experiments, I report unexpected results as well as expected ones.
61. I look forward to science lessons.
62. I would enjoy visiting a science museum at the weekend.
63. I would dislike becoming a scientist because it requires too much education.
64. Money used on scientific projects is wasted.
65. If you met a scientist, he would probably look like anyone else you might meet.
66. It is better to be told scientific facts than to find them out from experiments.
67. I dislike listening to other people's opinions.
68. I would enjoy school more if there were no science lessons.
69. I dislike reading newspaper articles about science.
70. I would like to be a scientist when I leave school.

Test of Science-Related Attitudes

Answer Sheet

Name ____________________

School ____________________ Year/Class ____________

Page 2						Page 3						Page 4					
	STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE		STRONGLY AGREE	AGREE	NOT SURE	DISAGREE	STRONGLY DISAGREE
1	SA	A	N	D	SD	29	SA	A	N	D	SD	50	SA	A	N	D	SD
2	SA	A	N	D	SD	30	SA	A	N	D	SD	51	SA	A	N	D	SD
3	SA	A	N	D	SD	31	SA	A	N	D	SD	52	SA	A	N	D	SD
4	SA	A	N	D	SD	32	SA	A	N	D	SD	53	SA	A	N	D	SD
5	SA	A	N	D	SD	33	SA	A	N	D	SD	54	SA	A	N	D	SD
6	SA	A	N	D	SD	34	SA	A	N	D	SD	55	SA	A	N	D	SD
7	SA	A	N	D	SD	35	SA	A	N	D	SD	56	SA	A	N	D	SD
8	SA	A	N	D	SD	36	SA	A	N	D	SD	57	SA	A	N	D	SD
9	SA	A	N	D	SD	37	SA	A	N	D	SD	58	SA	A	N	D	SD
10	SA	A	N	D	SD	38	SA	A	N	D	SD	59	SA	A	N	D	SD
11	SA	A	N	D	SD	39	SA	A	N	D	SD	60	SA	A	N	D	SD
12	SA	A	N	D	SD	40	SA	A	N	D	SD	61	SA	A	N	D	SD
13	SA	A	N	D	SD	41	SA	A	N	D	SD	62	SA	A	N	D	SD
14	SA	A	N	D	SD	42	SA	A	N	D	SD	63	SA	A	N	D	SD
15	SA	A	N	D	SD	43	SA	A	N	D	SD	64	SA	A	N	D	SD
16	SA	A	N	D	SD	44	SA	A	N	D	SD	65	SA	A	N	D	SD
17	SA	A	N	D	SD	45	SA	A	N	D	SD	66	SA	A	N	D	SD
18	SA	A	N	D	SD	46	SA	A	N	D	SD	67	SA	A	N	D	SD
19	SA	A	N	D	SD	47	SA	A	N	D	SD	68	SA	A	N	D	SD
20	SA	A	N	D	SD	48	SA	A	N	D	SD	69	SA	A	N	D	SD
21	SA	A	N	D	SD	49	SA	A	N	D	SD	70	SA	A	N	D	SD
22	SA	A	N	D	SD												
23	SA	A	N	D	SD												
24	SA	A	N	D	SD												
25	SA	A	N	D	SD												
26	SA	A	N	D	SD												
27	SA	A	N	D	SD												
28	SA	A	N	D	SD												

For Teacher Use Only

S ___ N ___ I ___ A ___ E ___ L ___ C ___

Appendix I

INSTRUCTIONS FOR ADMINISTRATION AND SCORING

Time required

1 No time limit should be applied when administering TOSRA (although it is not necessary to allow exceptionally slow students to finish). The approximate time taken for instructions and answering ranges from 30-45 minutes at the Year 7 level to 25-30 minutes at the Year 10 level.

Administration

2 Instruct students **not** to commence writing until told to do so.

3 Hand out the tests and the answer sheets.

4 Make it clear to students that the test is not for grading purposes.

5 Go through the Directions on the first page of the test thoroughly with the class and go over the Practice Item on the chalk board.

6 Emphasize that only one response should be circled for each item, that responses are to be given on the separate Answer Sheet, and that the way to alter an answer is to cross out the old answer and then circle the new choice.

7 Answer any reasonable student queries.

8 Tell students to write their names (if required), school, and year/class designation on the Answer Sheet, and then to commence answering.

9 During testing move around the class to check that pupils are answering as instructed. Continue to answer reasonable queries but do not encourage excessive queries.

10 Students who finish early should be given something quiet to do.

11 Collect the tests and answer sheets when all, or nearly all, students have finished. (It is not necessary to allow exceptionally slow students to finish.) Ask students to check that they have filled in the details on the Answer Sheet.

Scoring

12 Appendix II shows how the 70 items in TOSRA are allocated to the seven different scales and whether each item is positive (+) or negative (–) with respect to scoring. For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (–), responses SA, A, N, D, SD are scored 1, 2, 3, 4, 5, respectively. Omitted or invalidly answered items are given a score of 3. The seven separate scale scores are obtained by adding the scores obtained on all items within a given scale. Since each scale contains 10 items, the minimum and maximum scores possible on each scale are 10 and 50, respectively. Scale scores, however, cannot be added to form a meaningful total score. For people wishing to score TOSRA by hand (rather than by computer), use can be made of the convenient hand Score Key described below.

Hand Score Key

13 Check each student's Answer Sheet for any omitted items or invalid responses (e.g. more than one response circled). Amend each of these so that the N response is circled.

14 Place the transparent hand Score Key over the student's Answer Sheet so that the lines ruled on the Score Key correspond with those on the Answer Sheet. The score for a particular item is simply the number on the hand Score Key which is superimposed on top of the student's circled response.

15 Obtain the student's score for Scale S by adding the 10 scores for the individual items in this scale. Each of the 10 items belonging to Scale S is located as the first item in each block of seven items on the Answer Sheet. Also the Hand Score Key has the letter S written on it in various places to indicate which horizontal rows contain items belonging to Scale S. The total score for Scale S can be recorded in the space provided at the bottom of the Answer Sheet.

16 Obtain the student's total scores for the other six attitude scales by following a similar procedure, and record these scores in the spaces provided at the bottom of the Answer Sheet. Scales N, I, A, E, L and C consist, respectively, of the second, third, fourth, fifth, sixth, and seventh items in each block of seven items on the Answer Sheet. The hand Score Key contains the letters N, I, A, E, L and C to indicate which horizontal rows contain items belonging to the different scales.

Processing and Interpreting Results (Optional)

17 One of the most useful ways for teachers to process and interpret results is to calculate the mean score on each TOSRA scale obtained by a particular group of students (e.g. a class), to plot a profile of scale mean scores, and to compare this profile with that obtained for the field-testing sample (see Figure 1).

Appendix II

SCALE ALLOCATION AND SCORING FOR EACH ITEM

S Social Implications of Science	N Normality of Scientists	I Attitude to Scientific Inquiry	A Adoption of Scientific Attitudes	E Enjoyment of Science Lessons	L Leisure Interest in Science	C Career Interest in Science
1 (+)	2 (–)	3 (+)	4 (+)	5 (+)	6 (+)	7 (–)
8 (–)	9 (+)	10 (–)	11 (–)	12 (–)	13 (–)	14 (+)
15 (+)	16 (–)	17 (+)	18 (+)	19 (+)	20 (+)	21 (–)
22 (–)	23 (+)	24 (–)	25 (–)	26 (–)	27 (–)	28 (+)
29 (+)	30 (–)	31 (+)	32 (+)	33 (+)	34 (+)	35 (–)
36 (–)	37 (+)	38 (–)	39 (–)	40 (–)	41 (–)	42 (+)
43 (+)	44 (–)	45 (+)	46 (+)	47 (+)	48 (+)	49 (–)
50 (–)	51 (+)	52 (–)	53 (–)	54 (–)	55 (–)	56 (+)
57 (+)	58 (–)	59 (+)	60 (+)	61 (+)	62 (+)	63 (–)
64 (–)	65 (+)	66 (–)	67 (–)	68 (–)	69 (–)	70 (+)

For positive items (+), responses SA, A, N, D, SD are scored 5, 4, 3, 2, 1, respectively. For negative items (–), responses SA, A, N, D, SD, are scored 1, 2, 3, 4, 5, respectively. Omitted or invalid responses are scored 3.

APPENDIX H

Institutional Review Board Permission letter

Department of Chemistry

Middle Tennessee State University
P.O. Box 68
Murfreesboro, TN 37132
USA

Phone: [615]898-2956
Fax: [615]898-5182

To: Donald R. Perine

From: George Devendorf
Basic and Applied IRB Representative (phone: 2077)

Date: February 21, 2001

Re: Research Review: "The Underrepresentation of African-Americans in the Science Fields..." IRB Protocol #: 01-141

I have reviewed and approved the above named human subjects research proposal. This approval is for one year only. Should the project extend beyond one year or should you desire a change in the research protocol in any way, you must submit a memo describing the proposed changes (including changes in proposed interview scripts, etc.) or reason for extension to your college's IRB representative for review. As we mentioned in our conversation, please take care to guard the confidentiality of the personal identifying information in your possession and destroy such information after you have compiled your data. Best of luck in the successful completion of your research.

APPENDIX I

SECME Subject Research Review Letter

SECME

P. O. Box 1327
Mobile, Alabama 36633
690-8098

December 4, 2000

Ms. Myra Norman
Middle Tennessee State University
Office of Sponsored Programs
Box 124
Murfreesboro, TN 37132

RE: Regarding Human Subject Research Review Form

Dear Ms. Norman:

SECME was established in 1975 by the deans of seven southeastern universities. Today, SECME is the largest pre-college alliance in the country linking 41 universities; 70 industry/government agencies; 109 school systems; 19,199 students, and 900 K-12 schools in Alabama, Arizona, Arkansas, Florida, Georgia, Indiana, Kentucky, Louisiana, Maryland, Mississippi, New York, North Carolina, South Carolina, Tennessee, Texas, Virginia and the District of Columbia.

Mobile County Public School System SECME program typically has direct links with faculty of University of South Alabama, University of Alabama, Auburn University, Tuskegee University, University of Alabama at Birmingham, University of Alabama at Huntsville and is always interested in conducting research that fosters excellence in education. As program director of the Mobile County Public Schools SECME, Incorporated, I am pleased to assist Mr. Don Perine a doctoral candidate in the chemistry department at MTSU with educational research involving learning styles of African Americans.

The following middle school principals have consented to conduct research with seventh grade science students: James Brooks (Calloway-Smith Middle School), Hilda Wilson (Elizabeth S. Chastang Middle School), William James (Mae Eanes Middle School), Beverly Turner (Mobile County Training Middle School), and Rosalyn Dean (Booker T. Washington).

Sincerely,

Leevones G. Dubose,
Program Director

APPENDIX J

Principals' Consent Form

SECME

P. O. Box 1327
Mobile, Alabama 36633
690-8098

Letter of Consent

I, Leevones G. Dubose, along with the respective principals give consent to Don Perine to administer learning styles tests to seventh grade students.

Leevones G Dubose 12/04/00
Leevones G. Dubose (SECME Program Director) Date

12/4/00
James Brooks (Calloway-Smith Middle School) Date

Hilda Wilson 12/04/00
Hilda Wilson (Elizabeth S. Chastang Middle School) Date

12-04-00
William James (Mae Eanes Middle School) Date

Beverly Turner 12/04/00
Beverly Turner (Mobile County Training Middle School) Date

Rosalyn Dean 12/5/00
Roslyn Dean (Booker T. Washington) Date

APPENDIX K

Questionnaire & Consent Form

INDIVIDUAL QUESTIONNAIRE & CONSENT FORM

Learning Styles Test of African American College Students, Teachers and Professionals
in the Science fields

Under the Direction of
Dr. Pat Patterson
Middle Tennessee State University
Department of chemistry

You are invited to participate as a volunteer in a research program that has great potential. All that is required is that you fill out the following questionnaire and sign your name on the bottom line to give us permission for the use of your test results to make statistical comparisons. Detail directions of how to take the test will also be given to each participant. If you have any questions, please ask them before proceeding. Any information that you give which is of a personal nature (such as name, etc.) will not be released to anyone outside our research group. Your participation is greatly appreciated.

NAME: ____________________________ DATE: _________ TIME: _______

DATE OF BIRTH: _____________ AGE: _______ SEX: _________

I consent to the use of my test results by the research group of Dr. Pat Patterson. I understand that my name or other personal information will not be released to anyone else and will be used for statistical purposes only. I also understand that my participation is voluntary and that I can withdraw from this research at any time.

SIGNATURE: ____________________________________

APPENDIX L

Between-Subjects Factors

Between-Subjects Factors

TWO GROUPS	Value Label	N
1.00	Students	493
2.00	Adults	53

****

N = 493: Student Population

1. Calloway-Smith Middle School	100
2. Chastang Middle School.	99
3. Mae Eanes Middle School	99
4. Mobile County Training Middle School	100
5. Washington Middle School	95
TOTAL	493

N = 53: Adult Population

1. Middle Tennessee State Science Students	14
2. Dentist and College Professors (13 and 3)	16
3.Middle and High School Science Teachers	23
TOTAL	53

APPENDIX M

Descriptive Statistics

Descriptive Statistics

Subscale	Two groups	Mean	Std. Deviation
1 Noise Level	Students	44.88	9.95
	Adults	53.70	5.78
	Total	45.73	9.97
2 Light	Students	48.00	9.49
	Adults	53.58	7.11
	Total	48.54	9.42
3 Temperature	Students	49.56	10.92
	Adults	49.06	8.27
	Total	49.51	10.69
4 Design	Students	49.57	7.94
	Adults	52.09	7.72
	Total	49.82	7.95
5 Motivation	Students	53.61	10.06
	Adults	53.23	7.98
	Total	53.57	9.87
6 Persistent	Students	48.41	10.17
	Adults	53.92	7.36
	Total	48.95	10.06
7 Responsible	Students	54.77	10.00
	Adults	49.92	8.30
	Total	54.30	9.95
8 Structure	Students	57.00	9.93
	Adults	54.43	8.77
	Total	56.75	9.85
9 Learn Alone/Peer	Students	52.17	10.99
	Adults	51.91	11.31
	Total	52.15	11.02
10 Authority Figures	Students	50.06	10.75
	Adults	55.53	8.16
	Total	50.60	10.64
11 Learn Sev. Ways	Students	50.36	10.59
	Adults	47.74	9.07
	Total	50.10	10.47
12 Auditory	Students	47.17	12.40
	Adults	53.32	9.29
	Total	47.77	12.26

13 Visual	Students	50.49	11.05
	Adults	49.85	8.60
	Total	50.43	10.83
14 Tactile	Students	49.16	11.03
	Adults	55.02	10.02
	Total	49.73	11.06
15 Kinesthetic	Students	50.24	11.16
	Adults	52.08	7.71
	Total	50.42	10.88
16 Requires Intake	Students	50.86	9.58
	Adults	50.43	8.81
	Total	50.82	9.50
17 Even/Morning	Students	49.07	9.05
	Adults	48.38	8.37
	Total	49.00	8.99
18 Late Morning	Students	49.28	10.62
	Adults	48.68	10.20
	Total	49.22	10.57
19 Afternoon	Students	54.17	9.99
	Adults	54.00	11.46
	Total	54.15	10.13
20 Needs Mobility	Students	50.40	11.06
	Adults	49.53	7.91
	Total	50.31	10.80

APPENDIX N

Tests of Between-Subjects Effects

Tests of Between-Subjects Effects

Subscale Dep. Var.	Type III Sum of Squares	df	Mean Squares	F	Sig.
1	3724.34	1	3724.34	40.16	0.00
2	1491.58	1	1491.58	17.30	0.00
3	12.22	1	12.22	0.11	0.74
4	304.95	1	304.95	4.86	0.03
5	6.91	1	6.91	0.07	0.79
6	1454.35	1	1454.35	14.74	0.00
7	1123.00	1	1123.00	11.57	0.00
8	315.11	1	315.11	3.26	0.07
9	3.41	1	3.41	0.03	0.87
10	1428.42	1	1428.42	12.89	0.00
11	328.79	1	328.79	3.01	0.08
12	1810.23	1	1810.23	12.29	0.00
13	19.96	1	19.96	0.17	0.68
14	1643.70	1	1643.70	13.75	0.00
15	160.62	1	160.62	1.36	0.25
16	8.52	1	8.52	0.09	0.76
17	23.03	1	23.03	0.29	0.59
18	17.15	1	17.15	0.15	0.70
19	1.39	1	1.39	0.01	0.91
20	35.99	1	35.99	0.31	0.58

APPENDIX O

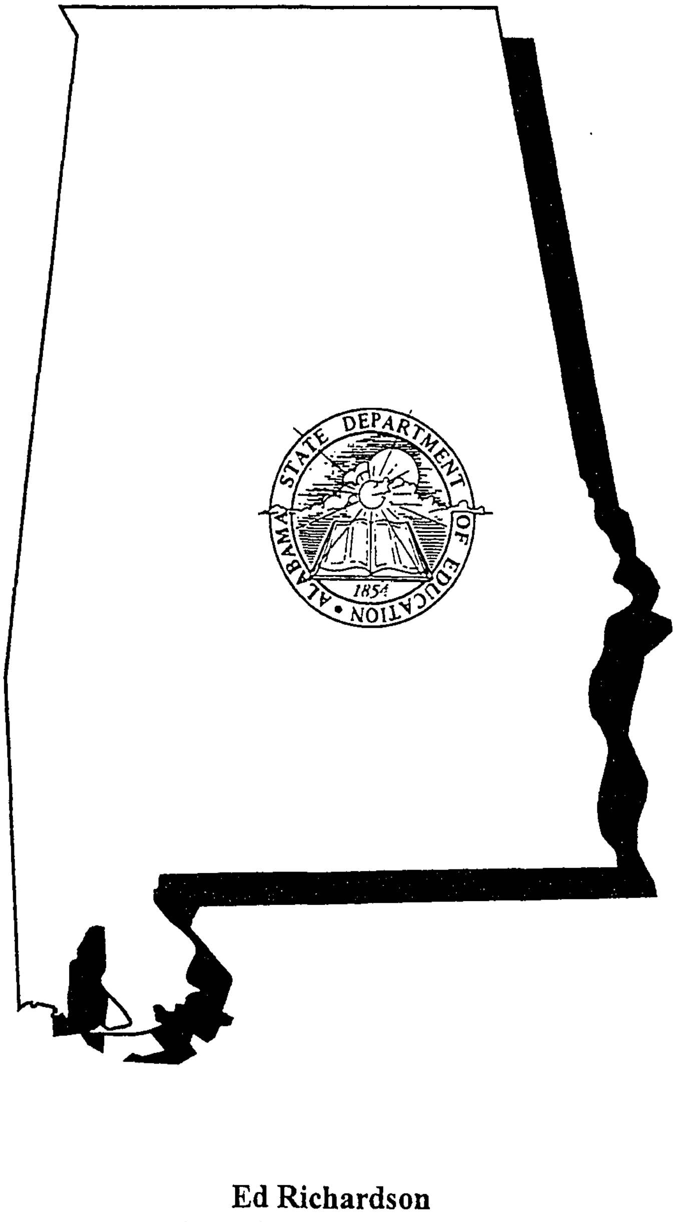
Alabama Course of Study

SCIENCE

Ed Richardson
State superintendent of Education
ALABAMA STATE DEPARTMENT OF EDUCATION
Bulletin 2001, No. 20

Alabama Course of Study

SCIENCE



Ed Richardson
State Superintendent of Education
ALABAMA STATE DEPARTMENT OF EDUCATION
Bulletin 2001, No. 20

Alabama Course of Study: Science

TABLE OF CONTENTS

ALABAMA'S K-12 SCIENCE CURRICULUM GENERAL INTRODUCTION

Scientific Literacy: A Goal for Alabama's K-12 Science Education Program

Scientific literacy for all Alabama students is the goal of Alabama's K-12 science education program. The *Alabama Course of Study*: Science (Bulletin 2001, No. 20) defines the minimum required content that students need to achieve the goal.

The *National Science Education Standards* produced by the National Research Council (NRC) has established scientific literacy as a national goal of science education and it continues to be a goal for Alabama students. Scientific literacy enables students to use scientific principles and processes in everyday life to make informed decisions. A solid foundation in science helps to develop and strengthen many of the skills that students use daily such as solving problems creatively, thinking critically, working cooperatively in teams, practicing stewardship of natural resources, and using technology effectively. The scientifically literate person is more likely to face with confidence the challenges of an ever-changing global society. Moreover, the economic productivity of Alabama is linked to the scientific and technological skills of the workforce.

To help students achieve scientific literacy and make sound decisions, the K-12 science program places a renewed emphasis on the importance of teaching science every day to every student in every grade. A child's sense of wonder should be encouraged. Alabama teachers should nurture young children's interests, curiosities, and impressions. During pre-adolescence the exposure to concrete facts, generalizations, theories, principles, and laws is begun. As students mature, knowledge of early concepts expands into more complete abstract understanding and complex applications. Instruction is focused on providing experiences, knowledge, and sills that allow students to build understanding of both the content of science and the nature of the scientific enterprise.

Thus, scientific literacy is best achieved through a K-12 science program that is inquiry-based and incorporates scientific knowledge and skills and incorporates opportunities to apply both in practical ways. If the goal of scientific literacy is met, then the investment in students' education will be worth the efforts and resources expended.

Grades 6-8 Overview

Middle school students exhibit a unique span of learning styles and intellectual abilities. This diverse range of developmental stages requires the implementation of a Grades 6-8 science program that is designed to engage students in multiple types of scientific inquiry. The required content for Grades 6-8 encourages an inquiry-based approach in the domains of Physical Science, Life Science, and Earth and Space Science. This format provides the teacher with ways to connect science ideas and concepts from grade to grade while enhancing them at appropriate developmental stages. Knowledge Standards in the Life Science domain are used to illustrate this concept. In Grade 6, the cell theory and single cell organisms are introduced to students. A study of cellular structure and function leads to a comparison of cells, tissues, organisms, and systems in Grade 7. Grade 8 students continue this concept development through a study of the human body systems. This format is used throughout all domains. Concept development reduces the need to "cover" large amounts of material at each grade level and exposes students to more depth of content. When possible, instruction should illustrate connections of content within a grade from different domains.

The minimum required program for Grades 6-8 includes the following content.

	6-8 Content Organizers		
	Sixth Grade	Seventh Grade	*EIGHTH GRADE*
Domains	**Process and Application Skills**	**Process and Application Skills**	**Process and Application Skills**
	KNOWLEDGE STRANDS	KNOWLEDGE STRANDS	KNOWLEDGE STRANDS
PHYSICAL SCIENCE	Properties and Changes in Matter	Properties and Changes in Matter	Properties and Changes in Matter
	Forces and Motions		Forces and Motions
	Energy Transfer and Transformation	Energy Transfer and Transformation	
LIFE SCIENCE	Structure and Function of Living Systems	Structure and Function of Living Systems	Structure and Function of Living Systems
	Diversity and Adaptations		Diversity and Adaptations
		Heredity and Reproduction	Heredity and Reproduction
	Organisms and Environments	Organisms and Environments	Organisms and Environments
EARTH AND SPACE SCIENCE	Dynamic Earth	Dynamic Earth	
	Earth in Space	Earth in Space	
			Ordered Universe

This Grades 6-8 science program also emphasizes teaching science as a process. The Process and Application Standards should not be taught as separate Content Standards but integrated with the teaching of the Scientific Knowledge Standards in each of the three domains. This approach combines reasoning and thinking skills with scientific knowledge. Students will be able to connect the skills and concepts of science to their daily lives by using the "hands-on" and "minds-on" approach to learning. Students should ask questions, design and conduct investigations, collect data, devise an answer to their questions, and share the process and results. Students should communicate their results orally and in writing. The results can be illustrated using concept maps, graphs, drawings, computer-generated spreadsheets, and graphics.

Teachers should create a flexible learning environment that encourages scientific inquiry. At these grade levels, a formal laboratory setting is preferred to insure that teachers and students can conduct safe, meaningful inquiry investigations. At a minimum, adequate space with appropriate furniture and safety equipment should be available. The scientific advances of the modern world create the need to integrate technology in scientific studies. Technology should be used in the classroom as a tool for investigations, inquiry, and analysis. Technology is integrated in the Process and Application Standards as well as within the Scientific Knowledge Standards in the different domains of the Grades 6-8 program.

Curiosity and creativity should also flourish in the science classroom. Teachers should develop activities that encourage students to use their imaginations for solving problems and designing investigations. Students should work in a variety of groups to foster collaboration among their peers. They should read, write, conduct experiments, and express ideas. Successful implementation of this classroom model will produce a science-literate community.

TEACHER TESTING TO RESUME IN ALABAMA

State Board of Education Approves Resolution

Montgomery, Ala. – The Alabama Board of Education approved a resolution today that reintroduces the testing of future teachers – an event that has seen a 17-year absence from Alabama classrooms. Today's resolution, which was adopted on a unanimous vote, establishes the new *Alabama Prospective Teacher Test.*

"This is a great initial first step," said State Superintendent of Education Ed Richardson. "The new testing program – along with our nationally recognized evaluation process, requirement to have teacher background checks, and holding our teacher preparation programs accountable – will help ensure we have the best teachers possible in our state's public classrooms."

Governor Don Siegelman stated, "Teacher testing is finally out of the courtrooms and back in the classrooms where it belongs. We have an obligation to Alabama's children to ensure they have the opportunity to reach their God-given potential through education, and teacher testing is an important step towards reaching that goal."

Any prospective teacher that wants a job in any of Alabama's 1,471 public schools must score at least at Level 4 to pass each section of the test. Currently, there are two components of the test: the *Reading for Information Test* and the *Applied Mathematics Test.* Both were developed using the highly regarded Work Keys System established by ACT Inc., and validated by Worldwide Interactive Network, for use in Alabama. A writing test is expected in the spring of 2003.

Level 4 standards for the mathematics test include the ability to work with positive and negative numbers, fractions, and percentages; calculate averages; use charts and graphs; and solve word problems. Level 4 reading standards include identifying important details in a reading assignment, applying complex instructions, recognizing cause-effect relationships, and determining the meaning of words not defined in the reading material.

The *Alabama Prospective Teacher Test* is an addition to teaching requirements already in place. Current or former teachers who allow their teaching certificate to lapse for more than six months must pass the test requirements prior to recertification.

The reading and mathematics tests will be a precondition for prospective teachers who apply for certification beginning January 1, 2003. The test can be taken any time before or after applying for certification from the state Department of Education. Some colleges and universities may require the test prior to admission into teacher training programs. However, no one applying for a certificate to teach in Alabama after January 1, 2003, will receive a certificate until the appropriate components of the Alabama Prospective Teacher Testing Program have been met.

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