A factor analysis of the preferred learning styles of Industrial Technology and Engineering undergraduate students at North Carolina Agriculture and Technical State University and at Iowa State University

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A factor analysis of the preferred learning styles of Industrial Technology
and Engineering undergraduate students at North Carolina Agriculture and Technical
State University and at Iowa State University

by

Dominick E. Fazarro

A dissertation submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Major: Industrial Education and Technology

Major Professor: Larry L. Bradshaw

Iowa State University

Ames, Iowa

2001

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This is to certify that the Doctoral dissertation of

Dominick E. Fazarro

has met the dissertation requirements of Iowa State University

Signature was redacted for privacy.

Major Professor

Signature was redacted for privacy.

For the Major Program

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For the Graduate College
DEDICATION

I would like to dedicate this study to my wife, Angela and my son. Asante for their love and support.
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ABSTRACT

This study examined the learning style preferences of African American and European American undergraduate students in the Industrial Technology and Engineering programs at North Carolina A&T State University and Iowa State University. In this study, the independent variables employed were ethnicity, discipline, and the named institutions. The dependent variables were the 20 learning style preferences in the Productivity Environmental Survey (PEPS). Convenience sampling was used to collect 540 students. A factor analysis was used to determine the preferred learning styles for African American and European American students at each institution. In addition, the hypotheses were tested by the Box’s M test in the discriminant analysis. The hypotheses were tested at an \textit{a priori} level of .05 to ascertain significant differences in the factor structures or groups. The findings of the study concluded that 1) there were differences in the factor loading profiles of African American and European American students at each institution, regardless of discipline, and 2) there were no differences between the factor loading profiles of Industrial Technology and Engineering students at either institution. Further analyses were generated to determine additional findings on African American and European American learning styles within their respective disciplines. The analyses consisted of examining if there were differences between factor loading profiles by combining both ethnic groups from each program, regardless of institution. The findings concluded that there were no differences between the factor loading profiles of the students enrolled in the two programs.
CHAPTER 1. INTRODUCTION

There has been a growing awareness among educators of the increasing diversity in college classrooms. Currently, institutions are seeing an increase in students of color who are pursuing more advanced degrees. By the year 2020, Pallas and associates predict that 46 percent of the student population in this country will be students of color (Pallas et al., 1989). In the 21st century, students of color and European Americans will be faced with increasing technological demands. European American enrollment in universities is projected to decrease from approximately 84.2 percent in 2000 (U.S. Census, 2000) to 63 percent by the year 2015 (Degroat, 2000). This change in the demographics of our nation and schools will have tremendous impact on the way faculty teach at universities and colleges. A deep understanding of how individuals or groups of individuals learn is essential to designing and implementing the shift in teaching practice so that all students benefit. According to Sims and Sims (1995), “Educators must have more knowledge and understanding of the learning process, particularly how individuals learn” (p. 1). Given this, more research is needed that pertains to learning style preferences of students of color, and particularly for those enrolled in technological programs at universities.

The development and study of learning styles has been an on-going process to help enhance learning in the classroom. Wooldridge (1995) defined learning styles as, “… an important element in the design of effective instruction and design and delivery” (p. 65). Brown (1998) augmented further emphasis to this definition by adding the following:

Learning styles and the creation of effective learning environments are of emerging significance in education as the changing nature of work requires higher-order thinking. (p. 1)
Learning style research, which has been occurring for many years, originally studied mainly K-12 students (American Association of School Administrators, 1991). The early studies on learning styles were also focused on primarily non-minority individuals. In addition, though few studies exist at the post-secondary level even fewer dealt with students of color (Swanson, 1995). Furthermore, only a handful were conducted in technology and engineering programs at post-secondary institutions. More recently there has been an emergence of studies on learning styles of students of color at the elementary and secondary school level, but post-secondary and technological program studies remain rare.

Many African American students at predominately white institutions (PWIs) continue to experience academic difficulty in their disciplines (Allen, 1987). The majority of African American students, who continue to struggle academically, are faced with a "traditional" pedagogy that does not complement the way they prefer to learn in the classroom (Hale-Benson, 1986; Kunjufu, 1984).

As the population of students of color increases, faculty will have a more challenging and difficult task in preparing these students for a high-skilled, technological society. This is all the more critical because all educational institutions are functioning in a state of greater accountability (Wooldridge, 1995). Many of these mandates focus on quality evaluation of instruction in the classrooms.

Students of color bring different kinds of learning style preferences to the classroom that faculty may not be able to address accordingly. Anderson and Adams (1992) state:

One of the most significant challenges that university instructors face is to be tolerant and perceptive enough to recognize learning differences among their students. Many instructors do not recognize learning differences among their students. Many instructors do not realize that students vary in the way that they process and understand information. The notion that all students' cognitive skills are identical at
the collegiate level [indicate] arrogance and elitism by sanctioning one group’s style of learning while discrediting the styles of others. (p. 19)

The study reported herein grew out of a personal observation of poor academic performance of African American students in a large Midwestern school district. Teachers were perceived as being of the diverse learning style preferences and environments of these students.

**Statement of the Problem**

To summarize, the problem observed is a lack of current and useful information about the learning styles of students of color in technical disciplines in post-secondary institutions. In addition, there is a weakness in the extent to which technical faculty and teaching assistants are informed about learning styles and their implications. The knowledge of teaching to various learning styles must be applied because Anderson (1992) warns “the amount of teaching done by students is now so large and pervasive as to threaten the validity of a university education” (p. 61). With this said, this study is envisioned as a first step in the continuing research to help improve teaching and learning in technical programs at institutions of higher learning. This study specifically examines learning style preferences among African American students currently enrolled in Industrial Technology and Engineering programs at two major universities.

**Purpose of the Study**

The purpose of this study was twofold: 1) to determine what the learning style preferences are for African American and European American students enrolled in Industrial Technology and Engineering, and 2) to ascertain if differences in learning styles exist
between African American students enrolled in Engineering and Industrial Technology at North Carolina A&T State University and European American students enrolled in the same disciplines at Iowa State University as measured by the Productivity Environmental Preference Survey (PEPS).

**Need for the Study**

The significance of this study is based on its contribution to the body of knowledge of learning styles. Its major contribution is the identification of the preferred learning styles of students of color in technological majors at the university level. This study provides insight for faculty who may be unaware of the learning preferences of students of color in university classrooms. The results of this study can provide assistance to faculty who may lack the expertise and knowledge to successfully teach the increasingly diverse population they are currently facing.

The need for the study is based on the reports of researchers who express concern over the lack of information on learning styles of African Americans in higher education. Researchers pointed out that information on learning styles could provide answers to improving learning environments (personal communication, Dr. J. Hale, Wayne State University, September 23, 1999; Dr. C. Melear, University of Tennessee–Knoxville; September 27, 1999; and Dr. R. Dunn, St. John’s University. December 7, 1999).

Many researchers stress that additional research is needed to improve and prepare faculty in the 21st century. Wooldridge (1995) emphasizes that,

Learning style research is critically needed in the following areas: learning styles of minorities, women, and international students; differences in learning styles of part-
time, non-traditional students; implication of learning styles for the use of technology in delivery of higher education; and the implication of individual learning style differences for the selection of the most effective instrument for different types of learning objectives. (p. 63)

There is a growing interest to improve undergraduate education in all disciplines (Anderson & Adams, 1992). Consequently, teaching and learning practices have become a top priority for school improvement in higher education (Claxton & Murrell, 1988). Claxton and Murrell explain learning styles as:

A concept that can be important in this movement [of improving learning], not only in informing about teaching practices but also in bringing to the surface issues that help faculty and administrators think more deeply about their roles and the organizational culture in which they carry out their responsibilities. (p. 1)

They also emphasized three reasons to conduct further investigation into learning styles of diverse students in colleges and universities. Claxton and Murrell state:

*The most pressing need* is to learn more about the learning styles of minority students—a particularly important subject in the face of participation and graduation rates that indicate higher education is not serving black students well. Changing demographics portend an even more diverse student body in the future, with increasing numbers of Hispanics and other ethnic groups. *Second*, research is needed to clarify how much difference it makes if teaching methods are incongruent with the students’ style. Studies that speak to the role and potency of style, seen in conjunction with other important variables, would help teachers significantly. *Third*, research is needed to illuminate the conjunctions and interactions between style, developmental stage, disciplinary perspectives, and epistemology. A better understanding of the link between them would provide a helpful framework for examining teaching methodologies, the role of learning in individual development, and use of the discipline to promote more complex and integrative thinking. (p. 2)

**Research Questions**

In order to examine the learning style preferences of minority and nonminority students in Industrial Technology and Engineering programs at Iowa State University and at North Carolina A&T State University, this research study addressed the following questions:
1. Does a difference exist between the factor loading profiles of the learning styles of African American students at NCAT and factor loading profiles of the learning styles of European American students at ISU?

2. Does a difference exist between the factor loading profiles of African American students enrolled in Industrial Technology when compared with African American students enrolled in Engineering at North Carolina A&T State University?

3. Does a difference exist between the factor loading profiles of the learning styles of European American students enrolled in Industrial Technology when compared with European American students enrolled in Engineering at Iowa State University?

Assumptions of the Study

The design of the study is based on the following assumptions:

1. The PEPS instrument employed by the study is valid and reliable.

2. Students followed the directions of the proctor and completed the instrument honestly.

Delimitations of the Study

This study was delimited by the following:

1. This study's samples were drawn from only two universities that offered both Colleges of Engineering accredited with the American Board of Engineering and Technology (ABET) and Industrial Technology programs accredited by the National Association of Industrial Technology (NAIT).
2. This study surveyed only two ethnic populations, African American and European American students.

3. This study surveyed only undergraduate students in two programs, Industrial Technology and Engineering.

4. Because of the instrumentation, this study focused on learning style preferences.

5. This study used a sample of convenience rather than a random sample, therefore, inferences are limited to the participants in the study for those closely like them.

Limitations of the Study

This study contained the following limitation:

Due to the low proportion of students enrolled in the Industrial Technology program at Iowa State University, a smaller return was obtained for the other programs in the study.

Definition of Terms

**ABET**: An acronym for Accreditation Board for Engineering and Technology. This professional association, founded in 1932, provides accreditation services for engineering programs throughout the United States (ABET Homepage, 2000, www.abet.org/abet_brochure.htm).

**African American**: An ethnic group of people with an original national origin in Africa (African American will be used interchangeably with Black).

**Cognitive Styles**: These styles are defined as "habitual modes of information processing, they are not simple habits in the technical sense of learning theory for they are not
directly responsive to principles of acquisition and extinction" (Messick, 1976, p. 6).

**Confused Loading:** In a factor analysis, when variables show similar loading on two or more factors, confused loading is deemed to occur.

**Culturally Induced Cognitions:** Refers to the act of knowing, mental processes, and perceptions through certain cultural patterns of socializing, up-bringing, and home structure (Hale-Benson, 1986).

**Doctoral/Research Universities-Extensive:** These institutions offer a full range of baccalaureate programs, are committed to graduate education through the doctorate, and give high priority to research. They award 50 or more doctoral degrees each year. (The Carnegie Classification of Institutions of Higher Education, 2000, www.carnegiefoundation.org/Classification/Index.htm).

**Engineering:** “The art and science by which the properties of matter and the sources of power in nature are made useful to man in structures, machines and manufacturing products” (Webster’s New International Dictionary, 1961, p. 848). Engineering is not used synonymously with Engineering-Technology.

**European American:** An ethnic group of people with an original national origin in Europe.

**HBCUs:** An abbreviation for Historically Black Colleges and Universities. These are predominately black schools created in 1865 under the Morrill Act to provide Blacks with educational opportunities (Freeman, 1998).

**Factor Loading Profile:** A pattern of loading for an individual’s factor scores.

**Industrial Technology:** A program that prepares students for technical and/or management-oriented positions in industry, government, and education. Industrial Technology is involved

**Learning Style:** “The characteristics of cognitive, affective, and physiological behaviors that serves as relative stable indicators of how learners perceive, interact with, and respond to the learning environment” (Keefe, 1979, p. 4).

**Learning Styles Inventories or Instruments:** These are valid and reliable tests that assess an individual’s preferred learning style. In addition, these tests measure how an individual is most likely to learn, remember, and achieve (Price & Dunn, 1997).

**Master’s (Comprehensive) Universities and Colleges I:** These institutions offer a full range of baccalaureate programs and are committed to graduate education through the master’s degree. They award 40 or more master’s degrees annually in three or more disciplines (The Carnegie Classification of Institutions of Higher Education, 1994, p. 1).

**NAIT:** An abbreviation for the National Association of Industrial Technology. This professional association was founded in 1965 and provides accreditation for Industrial Technology programs in the United States (NAIT Homepage, 1999, www.nait.org/home.html).

**Preferred Learning Style:** A student’s preferred way to obtain and retain new information (Price & Dunn, 1997).

**PWI:** An abbreviation for Predominately White Institutions. This refers to institutions of higher-education which, during the late 19th and early 20th century, served primarily for whites. Very few Black attended during that time (Freeman, 1998).
Structure of this Dissertation

Chapter 1, the Introduction, provides a brief overview of the literature pertaining to African American learning styles and provides the need for the study. Included in Chapter 1 is a statement of the problem, purpose of study, research questions, assumptions, delimitations, limitations, and definitions of terms.

Chapter 2, the Literature Review, describes the methodology for the development of the early stages of learning style research and how culture impacts learning styles among African Americans. This chapter provides a discussion on the various learning style instruments used based on the Curry's Onion Model of the topology of learning style instruments/models. In addition, there is a discussion of past studies conducted on learning styles in Industrial Technology and Engineering. The last section of Chapter 2 provides the history of Historically Black Colleges and Universities (HBCUs) and Predominately White Institutions (PWIs), as well as descriptions of the disciplines used in the study.

Chapter 3, the Methodology, documents the research design and methodology. Included in this chapter is a description of the sample, instrumentation, and collection procedures. The statistical analyses with their assumptions are then highlighted.

Chapter 4, the Findings, presents the descriptive and inferential statistics used to assess and analyze the collected data. The hypothesis tests and their significance are then presented.

Chapter 5, Summary, Conclusions, Discussion, and Recommendations, presents a summary of the findings of the study and provides the conclusions, discussions, and recommendations for practice and for additional research.
CHAPTER 2. LITERATURE REVIEW

This chapter explores related literature on learning styles that were examined for this study. The chapter is divided into eight sections. The first section starts with the Methodology for Researching the Literature. The second section, The Meaning of Learning Styles, defines the concept and differences between learning and cognitive styles. The third section, Overview of Learning Style Research, describes the origin of learning style research and its key features. The fourth section, Research on Learning Styles of African Americans, discusses the relationship between culture and preferred ways of learning for African American students. The fifth section, Learning Style Instruments/Models, describes instruments that quantify learning style preferences as related to selected models. The sixth section, Learning Style Research Conducted in Industrial Technology and Engineering, presents an overview of the studies conducted in the past five years in these technological fields. This section also describes the design limitations of models discussed in the previous section. The seventh section, Institutional Environments, provides a rationale for the inclusion of Doctoral/Research Universities-Extensive and Master Comprehensive I Universities in the survey. In addition, this section describes these two programs and how they are different. The final section concludes with a summary of the review of literature.

Methodology for Researching the Literature

Many sources of information in various educational databases addressed learning styles. Sources used for this study included educational journals, conference papers, the World Wide Web, and books. In addition, key indices such as Educational Research...
Information Center (ERIC), Journal Storage (JSTOR full text articles), and Dissertation Abstracts International (DAI) were used. To assist with the identification of appropriate documents, several keywords were utilized. The search logic utilized keywords that ranged from general to specific. These were learning, cognition, learning styles, cognitive styles, African Americans, cultural environments, and Industrial Technology and Engineering students. Serious effort was made to review literature published within the last ten years but historical and benchmark studies providing basic knowledge that is still valid were also reviewed.

The Meaning of Learning Styles and Cognitive Styles

Researchers have developed definitions of the research that has been conducted in this area. Unfortunately, these have not always contributed to an explicit understanding of the concepts. According to Keefe (1987), these concepts, learning style and cognitive style, are often used synonymously. However, they are not the same. Learning styles contain more elements and are more specific than cognitive styles (Kirby, 1979). Scarpaci and Fradd (1985) suggest that learning styles are "ways in which individuals perceive, organize, and recall information in their environment" (p. 184). The term learning style includes cognitive, affective, and physiological domains which are influenced by the environment (Keefe, 1987). Dunn, Beaudry, and Klavas (1989) support this description in their research on the effects of environmental, emotional, sociological, physiological, and cognitive preferences on student achievement. They conclude, "Learning style is a biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others" (p. 50).
In contrast, the definition for cognitive style is quite different. The meaning tends to focus on the innateness of the individual. Messick (1976) defines cognitive style as "habitual modes of information processing. These are not simple habits in the technical sense of learning theory for they are not directly responsive to principles of acquisition and extinction" (p. 6). In short, the idea of cognitive ways of learning may have more to do with the personality of individuals (Jonassen & Grabowski, 1993). Snow, Corno, and Jackson (1996) illustrate this as "perception and thinking" (p. 281), in terms of field independent/dependent, and spontaneity. Hansen (1995) supports this idea by stating that cognitive styles are "...measures [that] do not indicate the content of the information but simply how the brain perceives and processes the information" (p. 20). In essence, cognitive ability is the mental process by which knowledge is acquired through reasoning, perception, or intuition. The focus is on the fundamental nature of the individual as opposed to the environment which influences an individual's learning style.

Overview of Learning Style Research

This section provides a review of the literature on early learning style research, current research on learning styles, and opposing views on the topic of learning styles.

Early research between 1890s and 1940s

Learning style research first emerged around 1892, with the majority of the research appearing in the 1940s (Keefe, 1987), all of which represented one cultural group. These early studies were conducted on American males of European descent from middle class backgrounds (Swanson, 1995). Most of the research before the 1940s examined how
individuals learned cognitively using oral, memorization, or visual instructional formats (Keefe, 1987).

After World War II, research on cognitive learning continued at Brooklyn College, Fels Institute, and at the Menniger Foundation (Keefe, 1987). Researchers at Brooklyn College worked on the bipolar trait of "field dependence-independence." Researchers at the Fels Institute concentrated on analytic and non-analytical functions. For example, an analytical learner will analyze a situation carefully then proceed to answer the question, while a non-analytical learner makes quick responses or judgments. Researchers at the Menniger Group studied various ways of thinking and problem solving using analytical modes of learning.

These early studies provided essential information that helped form the basis for brain research by exploring global/analytical, field independent/dependent, and right or left-brain information processing (Dunn & Griggs, 2000). The relationship between how the brain functions and how information is perceived provides insight into how people learn. To clarify how the brain processes information, Hunt (1999), explains that information processed by the brain is connected to neural components or neurochemicals which allow us to perform cognitive functions. According to Sims and Sims (1995), people who use one side of their brain as the dominant processor more than the other may, in fact, be predisposed to a particular set of learning styles.

Recent learning style research between 1950s and 1990s

Learning style research is not just a concept anymore but rather, it seems, a "reality check" for educators. As practitioners become more aware of various learning styles, they are
more apt to modify their teaching behaviors. Although some educators do not favor learning style research, there is support for the use of this research in the classroom (Kaminski, 1999). Learning style research proliferated throughout the 1950s and 1970s, during which educators began to apply, as a direct result from this research, new teaching techniques in the classroom (American Association of School Administrators, 1991). Soon models, inventories surveys, and instruments of all kind were developed to quantify, measure, and examine students’ ways of perceiving and absorbing information.

The aim of learning style research is to find clusters of people who use similar patterns for perceiving and interpreting situations. Based on this information, we should be able to adjust educational environments to make them more efficient and successful places. (O’Connor, 2000, p. 2)

O’Connor further explains learning style research as, “... drawn out of studies about the psychological, social, and physiological dimensions of the education process” (p. 1). These dimensions are a fundamental part the learning process. The National Association of Secondary School Principals’ (NASSP) director of research, Jim Keefe (1979), describes learning style as:

[A] diagnosis [that] opens the door to placing individualized instruction on a more rational basis. It gives the most powerful leverage yet available to educators to analyze, motivate, and assist students in school...it is the foundation of a truly modern approach to education. (p. 132)

Between 1979 and 1989, learning style research was conducted at more than sixty universities (Dunn, Beaudry, & Klavas. 1989). In the article, “Learning styles: Key to improving schools and student achievement,” Dunn and Griggs (1989) pointed out that learning is not just receiving information from the teacher. Educators need to recognize that students come to their classes with diverse way of perceiving information and that students need suitable climates in order to perform to their maximum ability. They argued:
Learning style is not simply a concept discussed by researchers and psychologists. It is the key to improving school climate and student achievement by recognizing that all people are not the same, and that all students do not learn in the same way. (p. 1)

Snow, Corno, and Jackson (1996) have considered learning style constructs as orientations that about student performance. They state,

These orientations would represent consistent preferences for different courses, but also for particular approaches to learning—that is, learning strategies—resulting from the person’s personality traits, cognitive styles, motives, intentions, and perceptions of the course and content. (p. 251)

In all facets of education, students must have the opportunity to explore their learning capabilities to succeed academically. Carbo and Hodges (1988) explain that, "students who understand and then are provided opportunities to make use of their learning styles tend to feel valued, respected, and empowered" (p. 57). Similarly, Hein and Budny (1999) state, “Acknowledgement of students’ individual learning styles can play a critical role in the learning process. Furthermore, the use of formal learning style assessments can provide useful information that benefits the student as well as the instructor” (p. 7).

Teaching to specific learning styles has been implemented in practical ways which improve students’ academic performance. Researchers provide examples of case studies where teachers and students are benefiting from the use of learning style research (Klavas, 1994; Ryan & Dunn, 1999).

Klavas (1994) documents the success of a learning style program based on the Dunn and Dunn Model that improved test scores and achievement in an elementary school in Greensboro, North Carolina. The principal at this particular elementary school set up a learning style program for teachers to begin implementing. A year later, after using the
Dunn and Dunn contact activity packages, the students’ scores, as measured by the California Achievement Test (CAT) in math and science, improved from the 30th to 40th percentile. There was continuous improvement in all areas of student academics (Klavas, 1994).

Ryan and Dunn (1999) account for the success of learning style implementation in a Springfield, Missouri high school that was facing an increasing number of at-risk students. A learning style center was created within the school to try to help ninth-grade students through the transition of their first year in high school. The principal who implemented the learning style program found that the support of teachers and parents was needed to make this endeavor successful. It was found that both teachers and parents needed to be slowly acclimated to this new teaching and learning process. At first, teachers were frustrated with the slow pace and needed more guidance, however, they eventually understood that all students needed to be involved in the learning process, not just the high achievers, in order for the system to be successful (Ryan & Dunn, 1999).

According to Ryan and Dunn (1999), one educator from this case study provided a perspective which describes this new attitude and awareness of learning styles: “Students were so unique that they could not even be normal” (p. 98). Teachers came to realize that each student is a unique learner, an awareness that eluded them prior to implementing this program. This, in itself, is a step forward for any educational organization.

Inquiry into how people learn moved from the exclusive field of psychological research into K-12 classroom practice. Although many educators and researchers support the concept of learning styles, there are those who remain skeptical of the implications this
has on student ability to achieve academically. The next section explores some of these doubts.

**Opposition to learning style research**

Many educators (Davidman, 1981; Fizzell, 1982; Snider, 1990; Hickcox, 1995; Fierro, 1997; Stahl, 1999) are skeptical of the results from learning style research. This is due to a proliferation of hurried studies and the subsequently rushed and shallow implementation of findings into the classroom (Snider, 1990). Hickcox (1995) explains that the problems of learning style research have “continued in the face of significant difficulties in regard to the adequacy of learning style conceptualization” (p. 28).

Snider’s article, “Critique of the Research on Learning Styles” (1990), cites confusion with the definition as well as weaknesses in the reliability and validity of instruments used to identify appropriate instructional environments. Snider also maintains that learning style instruments that measure interaction between students' preferences and instructional treatments are questionable.

Davidman (1981) at the Department of Education at California Polytechnic State University examined the work of Dunn, Dunn, and Price. He argues that, “the Dunn/Price work on learning styles . . . promotes a ‘false sense of knowing’ in promoting the child’s judgments of his or her own needs, [and] undermines the greater vision of public education” (p. 641). In addition, the questions on the inventory are misleading and confusing. For instance, if the student took the inventory in late September and one of the questions asks if the student is “teacher-motivated,” if the student has not had time to get to know the teacher,
how can the student be “teacher-motivated”? These are the kinds of logistical and conceptual issues that trouble investigators.

Fizzell (1982) maintains that the philosophy and values of the models and inventories used to assess learning styles, and of course, of the developers of these models and inventories, must be carefully examined. Fizzell directly challenges the purpose of learning style research with “So what?”—so what if the styles are different from one student to another. He questions whether or not this means that student success depends entirely on his/her learning style. There are three questions posed by Fizzell: 1) What is the importance to the success of meeting style difference? 2) Can you adapt to a situation which does not fit your style? 3) What is the attitude of the school towards adaptability? Fizzell does not see a lot of worth in learning styles and feels others share his perspective. Fizzell (1982) states, “This position [on learning styles] is opposed by those who believe that it is in society’s best interest to educate all youth to master a predetermined set of goals needed to prepare students for life. Furthermore, they believe that 75 to 85 percent could achieve this by the age of 21 if we provided appropriate services” (p. 13). It would appear that these outcomes are too idealistic, therefore, quite unattainable according to this author.

Fierro (1997) surveyed 19 teachers in a Catholic elementary school in the Bronx. The focus of the questionnaire was to collect opinions on whether or not there is a significant difference in the learning styles among different cultures. The studied included students who were Irish American, Italian American, Polish American, and German American. Fierro concluded that the majority of the teachers did not see a difference in learning styles among these cultures. Most teachers believed that learning style was an individual preference, not a
group preference. It was recommended that teachers use learning styles for awareness only, not for teaching students based on their ethnicity (Fierro, 1997).

In a more scathing review, Stahl (1999) describes the use of learning styles as something akin to “fortune telling.” Stahl accuses those who use learning style instruments as making quick judgments about how an individual learns in a particular environment. These judgments derive from answers produced from ambiguous questions on learning style inventories. And besides, according to Stahl (1999), educators are reluctant to change their teaching strategies to align with student learning styles. In a study by Stahl that examined attitudes and perceptions of teachers attending learning style workshops, it was found that the teachers and principals did not see the information they obtained at these workshops any more valuable than the information received in a graduate course that focused on teaching (1999).

Educators and researchers who oppose the use of learning styles have a point. Not all studies pertaining to the implementation of findings from learning style research emphatically demonstrate that all teachers have successfully modified their teaching strategies or all students have achieved academically. Dunn (1984) states:

Educators often are reluctant to experiment with innovations until “hard data” provide evidence that the new concept or process produces academic achievement at statistically significant levels. Although waiting for such corroboration is reasonable, it often take years to design, conduct, evaluate, and report on experimental studies; getting information published and then read is an even greater barrier to change. (p. 10)

Given this line of reasoning, the planning of future studies as well as attempts to implement findings from these studies should be carried out with extreme precision and rigor. It also illustrates the need for additional studies that focus on specific groups, i.e., ethnicity, gender,
socioeconomic, age-specific, etc. The next section of this review of literature examines African American learning styles.

**Research on Learning Styles of African Americans**

Recently, researchers have come to accept the use of learning styles to improve academic performance for students, especially for students of color. Supporting this, Anderson (1995) maintains that it is important to observe the existence of learning styles among diverse cultures. He states, "... having the understanding of learning styles becomes more critical when applied to diverse populations and their success and failure in learning environments" (p. 76). Anderson suggests that learning styles of students of color are not formally recognized in the western philosophy of education. This is significant due to the increase of diversity in U.S. public schools. In order for the public school system to meet the needs of these students, there must be an understanding of how students of color learn in order for them to compete successfully in the classroom.

However, researchers who study the learning styles of students of color are cautioned not to attempt to use the findings to generalize about all people of color. Investigators of this area should adopt an inductive approach when making inferences. Anderson (1995) describes this approach as one,

> ... in which they identify the characteristic under study, connect it to a specific population, discuss how it can be observed and assessed, and end with suggestions for the teaching and learning environment. (p. 71)

Investigators need to careful because within today's diverse population there is a larger variation of learning styles within a group than between groups (Dunn & Griggs, 2000).
Cultural influence on learning styles

It is necessary to understand the differences that exist in the way information is perceived by African Americans, European Americans, and other ethnic groups. The reason for this understanding is to broaden the knowledge of educators and improve the quality of education for a pluralistic society.

Dunn and Griggs, (2000) denote differences among various ethnic groups in five areas of the stimulus. They are:

- **Cognitive style.** African Americans and Hispanics are significantly more field dependent and European Americans are more field independent. Asian Americans tend to have higher analytic skills than Native Americans. European Americans are higher in sequential processing skills than African Americans, whereas Native Americans are higher in simultaneous processing skills than European Americans.

- **Emotional stimulus.** Asian Americans tend to be significantly more persistent and motivated than Native Americans. Asian Americans prefer highly structured learning activities, whereas African Americans prefer minimum structure.

- **Environmental stimulus.** African Americans prefer quiet and dim lighting, whereas European Americans prefer sound and bright light. Asian Americans require a formal design, whereas European Americans prefer an informal design. African Americans concentrate better in a warm environment, whereas Native Americans and Hispanic Americans prefer cooler temperatures.

- **Sociological stimulus.** European Americans are more likely to prefer learning alone, whereas Native Americans are more peer oriented.

- **Physiological stimulus.** European Americans are significantly higher in auditory learning than Native and Hispanic Americans, who tend to be visual learners. African Americans are more likely than European Americans to prefer kinesthetic or experiential learning activities . . . (p. 17)

Although the Dunn and Dunn model, which is based on the above five stimuli, made an attempt to determine different learning styles among various ethnic group, it failed to identify the cultural origins of these differences (Claudia Melear, personal communication, August 2000).
Researchers (Piaget, 1966; Ramirez & Castaneda, 1974; Hale-Benson, 1986) have made an attempt to ascertain how culture impacts learning styles. However, linking culture to learning styles is indeed a controversial issue because of the propensity to compartmentalize groups to specific categories of learners (Guild, 1994). In an effort to adhere to this warning, Kolb (1981) maintains that as, “... a result of our hereditary equipment, our particular past life experiences, and the demands of our present environment, most of us develop learning styles that emphasize some learning abilities over others” (p. 237). Yet, Hale-Benson (1986) argues, “Attempts to understand the learning styles of Black children cannot advance without the development of an appropriate social-psychological theory of the educational process” (p. 5). Environmental factors may contribute to a common experience among people, but that in itself does not suffice in understanding of how Black children learn. The socialization of children both at home and in public institutions impact their learning ability.

According to Borich (1996), the socialization process is a factor in how individuals perceive information in their environment. Piaget (1966) identified four factors that influence cognitive functions through socialization:

(a) **Biological factors** depending on the “epigenetic system (maturation of the nervous system, etc.)...”, (b) **Equilibration or autoregulation factors**, determining behavior and thought in their various specific activities...”, (c) **General socialization factors**, which are identical for all societies: cooperations—discussions—oppositions—exchanges, etc. between children or between adults or between adults and children...”, and (d) **Factors related to education and cultural transmissions**, which differ from one society to another...” (p. 3)

Hale-Benson (1986) notes that these factors do not function separately, but may occur differently from one community to another.
Ramirez and Castaneda (1974) believe that the learning styles of people of color may originate from the dominant teaching style used in a home setting. They observed how Mexican-American children were failing in the western-Euro style education system. They explain that "values and socialization styles may determine or affect development of cognitive style in [students], and differences which parallel those seen in socialization processes" (p. 60). Figure 1 illustrates Ramirez and Castaneda's model of the relationship between culture and learning styles.

Ramirez and Castaneda's model provides a "naturalistic" approach of how the family lives within their culture. This model may be applied to the way African Americans perceive information as a result of their cultural influences. It's possible that African Americans have a social and teaching structure in the home that conflicts with the European learning format. Despite this assertion, Ramirez and Castaneda (1974) explain that a student can be attached to his or her traditions and home lifestyles yet still succeed in the "mainstream" system of learning. Gordon (1976) states, "learning differences are important, and in spite of political

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**Figure 1.** Relationship between culture and learning styles (adapted from Ramirez, M. & Castaneda, A. [1974], *Cultural democracy bicognitive development and education*)
and social consequences, they must be recognized in the educational process” (p. 169). It seems a balanced learning environment between the home and school can satisfy the different learning styles needs of individuals.

Learning styles of African Americans

The preferred style of learning among European Americans, which is analytically oriented, may be the only style recognized in the education system. As a result, many African American students experience a failure pattern in schools structured and designed by the dominant culture (Boykin, 1983; Hale-Benson, 1986; Hilliard, 1992; Melear, 1995). This creates a compelling need to examine learning styles of specific ethnic groups. It also points to a need to assist educators in modifying their teaching strategies in order to meet the needs of these marginal groups.

Researchers (Boykin, 1983; Hale-Benson, 1986) have made an effort to create learning style inventories that are culturally based. Bell (1994) suggests that African American learning styles are based on the African worldview and cultural consciousness. Bell’s belief suggests that African American learning styles are based on the philosophy of African education and that this affects how they process and retain information. Hale-Benson (1986) also notes that African Americans’ learning styles originate from West Africa. Four culturally induced cognitions were derived from her study, which include: 1) person-centered, 2) affective, 3) expressive, and 4) movement-oriented (Hale-Benson, 1986).

Boykin (1983) looked at African Americans as being “holistic,” and identified nine characteristics to explain the learning characteristics of African American students,
which are: 1) spirituality, 2) movement, 3) orality, 4) affect, 5) communalism, 6) harmony, 7) expressive individualism, 8) verve, and 9) social–time perspective. These nine aspects are similar to Hale-Benson’s Black learning styles, and both subscribe to the African American holistic pattern of learning.

Ignoring the cultural origins or aspects of how students of color learn will further perpetuate the belief that nothing is wrong with our educational system. Bennett (1986) states:

If classroom expectations are limited by our own cultural orientations, we impede successful learners guided by another cultural orientation. If we only teach according to the ways we ourselves learn best, we are also likely to thwart successful learners who may share our cultural background but whose learning styles deviate from our own. (p. 165)

It is imperative that taking into account the cultural orientation of individuals or groups of individuals also includes a close examination of the differences in the socioeconomic status of various groups of people.

Connection between learning styles and socioeconomics

Research suggests that learning styles of African Americans and other minorities are strongly influenced by economic status and social class, and suggests that this is what causes a variance in behavior within ethnicities (Banks, 1988).

Milton Gordon’s book, Assimilation in American Life (1964), discusses social class differences among various ethnic groups. Gordon hypothesizes that social-class differences are more important than ethnic group differences. Gordon suggests that social class affects and molds behavior. Gordon’s intention was not so much to look at ethnicity,
but to determine the realities of a social system that forces assimilation into a dominant culture that does not fully embrace ethnic diversity.

White (1992) cites research showing that middle-class European Americans perform better in school than middle-class Blacks. It seems that European Americans are more acclimated to the prevailing “analytical” nature of teaching and learning than Blacks.

Atkisson (1991) interviewed James Vasquez, an educational psychologist at the University of Washington. Vasquez believes that socioeconomic status has a relationship to how individuals learn. Members of the middle class tend to be field-independent but the lower classes tend to be field-dependent. Vasquez explains that social class may impact how parents teach their children at home. An important factor is extent of the “academic and culture-rich” environment of the home; for example, do these homes have dictionaries, encyclopedias, computers, and are children taught about their family history consistently and in a positive context, etc.

In essence, the academic and culture-rich environment of the home is crucial to how well learning occurs. A poor home environment may lack actual physical resources but may be rich with cultural knowledge and experiences unique to that particular family. The next section describes the learning environment which, as we know, plays an essential part in the development of learning styles.

Learning Environment

Knowles (1970) refers to the concept of a learning climate. He claims that the learning climate should not only satisfy the social needs, but the physical needs of
individuals, if academic success is to be attained. Greeno, Collins, and Resnick (1996) suggest that the purpose of a learning environment serves "... to foster students' learning and to support the development of students' personal identities as capable and confident learners and knowers" (p. 27). This statement proposes a "realistic" rationale but there are still problems with the current educational system. Students of color continue to fall behind academically. Therefore, learning environments may represent social and political concerns that impede success of all students (Imel, 1995).

As the number of students of color increases, in college classrooms, learning environments must become more inclusive. Tisdell (1995) claims that there are three levels of inclusiveness. These environments should:

(a) reflect diversity of those present in the learning activity itself in the curriculum and pedagogical/andragogical style, (b) attend to the wider and immediate institutional contexts in which the participants work and live, and (c) in some way reflect the changing needs of an increasingly diverse society. (p. 4)

The climate in which students experience the greater part of their learning becomes very important in the context of understanding learning styles. It has been demonstrated that in order for students of color to succeed academically, the classroom environment must be conducive to learning.

**Learning Style Instruments/Models**

Over the years, many researchers (Kolb, 1978, 1981; Curry, 1983; Felder & Silverman, 1988; McCaulley, 1990; Price, 1996) have developed numerous models and/or instruments that quantify individuals' learning preferences, improve students' learning, and
help teachers provide better instruction. This section will examine those models or inventories that are most commonly used by researchers and practitioners.

Curry's Onion Model

Curry (1983) reviewed learning style instruments in the field of education and concluded:

1. Learning style researchers have not yet unequivocally [sic] established the reality or utility of this concept. Learning styles indeed may not exist other than as an insubstantial artifact of the person-environment interaction. An alternative may be real, stable and potent enough to be very useful educational planners, particularly those concerned with truly individualized educational programming.

2. There is enough suggestive and substantive work utilizing learning style concepts, enough of it with a clear professional focus to warrant an organized program of investigation. (pp. 9-10)

There are many learning style instruments that examine various aspects of an individual's style of learning. Curry (1983) of Dalhouse University in Halifax, Nova Scotia, created a model that would minimize confusion and overlap of the definition, define variable concepts, and categorize individual behavior. Curry's learning style model resembles an onion. The Onion is made up of three layers of learning styles, 1) instructional preference, 2) informational processing style, and 3) cognitive personality style. See Figure 2 for a graphic model of the Onion.

Curry (1983) provides an explanation of the three layers of the Onion Model.

- The outermost layer, and the most observable layer is Instructional Preference. Instructional preference refers to the individuals' choice of environment in which to learn. As this is the layer that interacts most directly with learning environments, learner expectations, teacher expectations and other external features. [This layer is] the least stable, most easily influenced level of measurement in the learning styles arena. (p. 8)
• The second level of the learning style onion is called *Informational Processing style*. This is conceived of as the individual’s intellectual approach to assimilating information following the Information Processing Model. Because this processing does not directly involve the environment we would expect that measures of this Informational Processing Style would be a good deal more stable than Instructional Preference. (p. 8)

• The third and innermost layer of the learning style onion is [the] *Cognitive Personality Style*. This is defined as the individual’s approach to adapting and assimilating information; but this adaptation does not interact directly with the environment, rather this an underlying and relatively permanent personality dimension. (pp. 8-9)

Marshall (1987) confirmed the validity of Curry’s work by conducting a study that examines the construct validity of the Onion Model. He concentrated on the instructional processing layer of the onion to ascertain if the model explained the third layer of the instructional processing topology. Marshall concluded,

This study does provide evidence that the topology has promise as a tool in learning style research and application. As a starting point, the topology can be

![Curry's Onion classification of learning style models/instruments](image)

*Figure 2. Curry’s Onion classification of learning style models/instruments (from Curry, L. [1983] and McShannon [1998]*)
used for classifying learning style models and instruments into a meaningful structure. It can provide a framework for the re-examining of much of the earlier research and for conducting future research. (pp. 426-427)

Curry's Onion Model is applied to several different types of commonly used instruments. These are classified according to the layers. The cognitive processing style instrument used to assess the inner layer (cognitive personality style) of Curry's onion is the Meyers-Briggs Type Indicator. The second layer, which reflects the informational processing style, uses the Kolb's Learning Style Inventory and the Felder-Silverman Learning Style Model. The outer layer, which points toward the instructional format preferences, uses the Productivity Environmental Preference Survey (PEPS). These instruments will be discussed in greater length in the next section.

**Instruments classified as Cognitive Personality Style**

Isabel Briggs and her mother, Katherine C. Briggs, developed the Meyers-Briggs Type Indicator (MBTI) in 1942 (McCaulley, 1990). Their work was based on Jung's (1923) theory of the way individuals use various functions of attitude that influence decision making in all areas of life. Jung's theory used a cerebral model that focused on four preferences: 1) sensing, 2) intuition, 3) thinking, and 4) feeling. These four preferences led to sixteen types that use four-letter indicators to create an individual's combined preferred style, either introversion or extroversion (e.g., favored action [E], imagination [N], values [F], and flexibility [P]). Combined, the four indicators provide a description of a personality style. Instruments that are classified as Cognitive Personality Style are in the cognitive domain of the term learning style.
Instruments classified as Informational Processing Style

Kolb (1981) created a learning style instrument based on his Experimental Learning Model that contains these domains, abstract-reflective, abstract, and concrete. The inventory consists of a nine-item questionnaire that yields a self-assessment of one’s preferred learning style (Kolb, 1978). Henak (1992) identified Kolb’s four types of learning styles:

- **Divergers** prefer to grasp information by being absorbed with an event (Concrete Experience) and then transform it by thinking, discussing, clarifying, or judging its value (reflective observation). Their strengths are in the imaginative ability. They like to view situations from different perspectives and then weave relationships into meaningful whole. (pp. 24-25)

- **Assimilators** prefer to grasp experiences by systematically researching ideas, theories, and processes (abstract conceptualization) and transform the information by describing, conceptualizing, generalizing and diagramming. They are best at understanding a wide range of information and putting it into a logical form. (p. 25)

- **Convergers** like the practical application of ideas and theories. They grasp experiences through careful and systematic study (abstract conceptualization) and transform that experience by testing, trying, and applying it to practical situations and problems (abstract conceptualization). They are good at deductive reasoning, defining and solving problems, and decision making. (p. 25)

- **Accommodators** prefer to grasp information by engaging themselves in activities that test, try, and such things as related ideas, skills, or processes (Concrete Experience). What they learn from the experience is transformed by using trial and error methods and observation (active experimentation). (p. 25)

Next, Felder (1996) worked with Linda Silverman to develop a model to examine students’ learning styles in order to help them perform better academically in engineering.

This model classified students as:

- **Sensing Learners** (concrete, practical, oriented toward facts and procedures) or **Intuitive Learners** (conceptual, innovative, oriented toward theories and meanings);

- **Visual Learners** (prefer visual representations of presented material—pictures, diagrams, flow charts) or verbal learners (prefer written and spoken explanations);
• **Inductive Learners** (prefer presentations that proceed from the specific to the general to the specific);

• **Active Learners** (learn by trying things out, working with others) or reflective learners (learn by thinking things through, working alone); and sequential learners (linear, orderly, learn in small incremental steps) or global learners (holistic, systems thinkers, learn in large steps).  (p. 3)

It was found that many engineering students who were studied using the Felder-Silverman Learning Style Model are visual, sensing, inductive, and active learners (Felder, 1996). However, the discipline of engineering has the curriculum built around an auditory, deductive, passive, abstract (intuitive), and sequential format (Felder & Silverman 1988). Felder and Silverman (1988) argue that in engineering, mismatches are common among students’ learning styles and the traditional teaching styles. As a result, students become discouraged and disinterested, and eventually transfer to another program or drop out. Beasley, Huey, Wilkes and McCormick (1995) contend that the curriculum is not conducive to all cognitive styles used by students. They argue that “those students who are disadvantaged early are disproportionately discouraged and drift away from engineering in greater numbers before given a chance to play to their strengths” (p. 4d3.8).

Even though this inventory is used in engineering, there is a need for more reliability and validity work. Furthermore, this inventory does not reflect the academic potential of any student who wishes to pursue other disciplines or professions.

**Instruments classified as Instructional Preference**

The Productivity Environmental Preference Survey (PEPS) is known to be the first instrument that recognizes learning style preferences and productivity of adults (Price, 1996). Gary Price helped to develop 20 elements (learning styles) specifically to analyze
adults' learning styles in a work environment to help maximize production. It should be noted that this instrument looks only at how adults learn, not at the way they perceive information. This instrument does have limitations to the extent of skills used to perform a task (Price, 1996). The theoretical framework for the PEPS is based on Dunn and Dunn's learning style model as shown in Figure 3.

Figure 3. Learning Styles Model (from Teaching Secondary Students Through Their Individual Learning Styles: Practical Approaches for Grades 7-12 (p. 4), by R. Dunn and K. Dunn, 1993, Boston: Allyn and Bacon. Copyright 1993 by Allyn and Bacon. Reprinted with permission)

Some of the elements from this survey are characteristic of learning style preferences rather than describing actual learning styles. Some elements characterize environments because students interact with the environment when they learn. When individuals take the survey, they must delineate between perception and reality. They are responding to statements about
how they think they prefer to learn rather than determining their actual preferred learning styles. The students’ responses or stimuli originate from the home or from cultural experiences, and this determines how comfortable they feel in ascertaining why individuals prefer certain learning styles. The Dunn and Dunn model does not ascertain the cultural origins of the individual’s learning styles or why students prefer a particular learning style preference.

Finally, there are two additional instruments that are not classified by Curry’s Onion Model but deserve mentioning. These are the Principles of Adult Learning Scale (PALS) and McShannon’s Questionnaire.

PALS was published in 1979 by Dr. Gary Conti. The instrument was developed for adult education practitioners to follow the learning principles of Adult Education and to ensure that these principles are consistent with the teaching-learner mode (Conti, 1982). This instrument was developed to measure various constructs for cognitive and affective domains and teaching styles of instructors (Conti, 1979). Based on the design of the instrument, PALS can be used as a learning style instrument for students and as a teaching style instrument for instructors. The instrument consists of 44 items using elements of learner-centered and teacher-centered approaches.

McShannon (1998) designed an instrument to address an interactive learning style model in 1996. The instrument consists of 24 statements on a five-point Likert Scale of Strongly Agree, Agree, Neutral, Disagree, and Strongly Disagree. Students were asked to rank these statements using the Likert scale ratings. The design of the instrument was based on two learning environments (formal and informal) and three interaction types (student-student, student-faculty, and student-self).
In summary, there are both limitations and benefits of the instruments used to measure how people learn. Using Curry's Onion Model can classify instruments according to what is being assessed. The PEPS, developed by Dunn and Price, will be used for the purpose of this investigation. There are two reasons to use this instrument: 1) the instrument is designed for adults, and 2) the instrument encompasses affective and physiological domains as well as cognitive.

Learning Style Research Conducted in Industrial Technology and Engineering Fields

Research on learning styles in the fields of Industrial Technology and Engineering can add to the body of knowledge, in terms of specialized disciplines in higher education. In addition, studies that examine learning styles of African American students in these two disciplines are important in helping administrators and faculty become more aware of how students learn at post-secondary institutions. This section will review published studies investigating the learning style differences in the two programs.

Examining learning styles in Industrial Technology

Spoon and Schell (1998) examined learning styles of students and teaching styles on the achievement of basic skills. Their objectives were 1) to determine the perceived learning styles of students and perceived teaching styles of teachers, 2) to determine if age, ethnicity, and gender influence learning styles and their interactions, 3) to determine the levels of congruency and incongruency between learning and teaching styles, and 4) to compare if levels of achievement for students whose learning styles are congruent or incongruent with
teaching styles. A causal-comparative design was used to examine the differences between groups. The targeted population consisted of twelve teachers who taught adult basic skills and 189 students between the ages of 16 and 67 at a technical institute. Of the 189 students studied, 119 were female and 70 were male. The ethnicity of the sample size in this study was 49.70 percent African American and 50.30 percent Caucasian. Spoon and Schell used the Principles of Adult Learning Scale (PALS) developed by Dr. Gary Conti of University of Montana. This inventory is used as a teaching or learning style inventory. This is achieved by restating the questions to examine teaching or learning styles. Data from the Test of Adult Basic Education (TABE) were collected as a pretest and posttest measure which determined if the preferred learning styles had an impact on the TABE scores.

Findings in the first objective revealed that three-fourths of the students preferred a teacher-centered style. The preferred teaching styles for the instructors were moderate teacher-centered. Findings in the second objective revealed that age was the only independent variable that was significantly related to learning styles. The third objective findings revealed in the age range of 35-44, 30.16 percent were incongruency, ages of 25-34, 41.20 percent were congruent. By ethnicity, African Americans and Caucasians made up a larger percentage of incongruency than students by age. In addition, there were no significant differences among the groups for initial equivalence pretest scores for the TABE. The fourth objective findings revealed there were no significant differences and no interactions of the teaching style and learning style on student achievement.

They concluded that learning style is influenced by age, especially the older population. Age may contribute to a long absence of schooling that may contribute to a need
to become re-familiar with learning in a classroom environment. Furthermore, Spoon and Schell cautioned vocational teachers not to generalize from the results of the study.

McGowan (1997) measured 68 African American students and ten faculty members in the Industrial Technology Department at Alcorn State University to ascertain whether students' learning styles were congruent with faculty's learning styles. In addition, he examined the preferred learning styles of students in relation to academic achievement. Using the Kolb Learning Style Inventory, McGowan found that some differences exist in learning styles among students and faculty. McGowan indicated that, "... twenty-four students were identified as the assimilator type, twenty-one students were the diverger type, eighteen were accommodators, and only five were convergers ... Industrial Technology faculty's predominant learning style was primarily the assimilator category" (p. 77). An ANOVA was conducted to test for significant differences existing between academic achievement levels and a preferred learning style but none were found. There were no significant differences. McGowan also investigated whether or not any differences in academic achievement could be attributed to students' dominant learning styles. No significant differences were found.

Examining learning styles in Engineering

McShannon (1998) examined a model of interactive learning styles and determined if there were any differences by gender, ethnicity, and college classification for engineering using a self-made instrument. She gave 515 engineering students (freshman, sophomore, junior, and seniors) questionnaires to test a model of interactive learning styles. She used LISREL and SAS to conduct the analysis. She concluded that 1) interacting outside of class
was more important for females than males, 2) interacting outside of class and answering students questions were more important to freshman than seniors, 3) learning opportunities were more important to males than females, 4) learning with other students or cooperative learning was more important for minorities than European American students, and 5) learning with other students or cooperative learning as well as learning alone was more important to seniors than freshmen. McShannon urges administrators to incorporate interactive learning style models to design engineering programs to retain a diversity among students.

Research design concerns

In addition to their findings pertaining to learning styles, the studies that were reviewed provide a wealth of insight into investigating analytical methodology. In the previous section, researchers provided studies that indeed made a contribution to the body of knowledge for examining learning styles in technological programs. There are three concerns about these studies that should be addressed: 1) a need for more extensive explanation of the reasoning behind the sampling technique and statistical analysis used, 2) the studies discussed used different instruments, which makes it difficult for researchers to compare results, and 3) ambiguities as to whether these studies assessed learning style or cognitive style.

The first concern addresses a need for further explanation of the sampling method and statistical analysis used for these studies. Often, the justification for using a particular sampling technique is not clearly stated. The reasons for sampling may be understood by the researcher, but they often are not communicated well to the reader. A majority of
statistical designs such as multivariate analysis are best used for probability sampling. The assumptions for most statistical methods do require the sample to be randomly chosen. However, the majority of learning style studies use convenience sampling, which is a nonprobability method. Learning style researchers cannot use random sampling because of the likelihood of a low participation rate. Furthermore, convenience sampling provides the opportunity to collect subjects according to a particular criterion, such as, ethnicity or discipline. Researchers should carefully analyze the requirements of statistical method(s) before employing them in their studies.

The second concern is that the identified studies use different instruments. This makes it difficult for other researchers to compare results of their own data with other studies. Snow, Corno, and Jackson (1996) stated that, “Several of the inventories overlap, showing apparently similar affective and cognitive scales that may not be empirically similar” (p. 282). Learning style researchers provide different variables to achieve the same purpose; that is, to assess one’s learning style(s).

The third concern is the researcher’s intent to examine learning styles or cognitive styles. The studies (McGowan, 1997; Spoon & Schell, 1998) that were reviewed used a cognitive style instrument to assess the students’ learning styles. Based on Curry’s Onion Model of classification of learning style instruments, these instruments are considered “informational processing.” According to Jonassen and Grabowski (1993), the instrument used in McGowan’s study, which was the Kolb Learning Style Inventory, is defined as “one’s preferred methods for perceiving and processing information” (p. 249). McGowan’s effort to determine the students’ learning styles do not agree with the purpose of Kolb’s inventory or the definition of learning styles.
One facet of the Spoon and Schell study was to examine the preferred learning styles of students. The instrument they used to determine the preferred learning styles was the Principles of Adult Learning Scale (PALS). According to Spoon and Schell (1998), this instrument was designed to “measure several constructs of cognitive and affective domains....” (p. 4). This instrument may not agree with the terminology “learning style,” even though the researchers’ purpose was to determine the learning styles of individuals.

McShannon’s study examined how the sociological aspects of learning styles (e.g., informal and formal) influenced students’ learning. Her focus on the sociological aspect of the students she studied is considered to be in the affective domain. The affective domain, according to Keefe (1987), is part of the larger concept of “learning style,” which in turn, falls under the umbrella of the learning climate. Both concepts are encompassed within the institutional environment.

Institutional Environments

The purpose is to provide information on the two types of institutions that are involved in this study. The cultures inherent in these institutions might help determine how and why students from both institutions exhibit differences as well as similarities in the way that learning occurs.

History of HBCUs

The birth of Historically Black Colleges and Universities (HBCU) was created out of a system of education where Blacks had unequal access to white schools (Freeman, 1998). HBCUs provide a nurturing environment for learning and growth. HBCUs as
identified by the Carnegie Classification system, are recognized by the U.S. Secretary of Education. There are 120 HBCUs that consist of community colleges, and public and private universities operating in the United States today (Carnegie Classification, 1994).

After the Civil Rights Act of 1964, African Americans had a wide selection of PWIs to attend. By 1980, there were 1.2 million African Americans attending college; however, only 20 percent were going to HBCUs. Even though HBCUs have been challenged with low budgets and resources, they have managed to play an integral part in producing strong leaders in an oppressed society (Freeman, 1998).

The environment of HBCUs is “culturally” more helpful to African Americans than PWIs (Allen, 1987). Even though a large percentage of Blacks attending HBCUs come from a low socioeconomic background, they become well adjusted to academic life (Allen, 1987). Fleming (1984) researched Black universities in the south and concluded that “… black colleges promote good intellectual growth from freshman to senior year” (p. 48). Furthermore, there is a sense of the cultural awareness of “self” and a stronger sense of upward mobility resulting from academic achievement (Fleming, 1984). These traits help Black colleges produce well-qualified and competent graduates as well as benefiting other students coming from top-flight predominately white institutions (Garibaldi, 1991).

**History of PWIs**

Historically, predominately white institutions consisted mostly of small colleges devoted to teaching the classical curriculum, such as mathematics, Greek, Latin, and philosophy (Sample, 1972). According to Sample (1972), these colleges, “were in the real
sense anti-intellectual, in that they were not concerned with critical examination of ideas, nor with development of creative and judgmental abilities of their students” (p. 18).

In the late 1800s, American educators adopted some of the educational methods used by the German universities. Americans redesigned their higher education system to include scholarship and research, even though these were not, at first, popular with faculty and students. The German system was first established in higher education originally and then extended to the K-12 system (Sample, 1972). The American system of higher education soon became the envy of the modern world. However, modern America was soon to experience the demands of a changing, more pluralistic society. American education realized it had to change in order to meet the demands of a new society.

Today, there are approximately 2,572 public and private four-year predominately white institutions, and community colleges under the Carnegie Classification system (Carnegie Classification, 2000). Since the 1960s, African Americans enrolled in PWI universities have doubled. More African Americans attend PWIs than HBCUs (Allen, 1987). The reason for this is because, between 1969 and 1979, affirmative action laws provided for more greater educational opportunities for African Americans to enroll at PWIs (Evans. 1986).

**History of Industrial Technology and Engineering**

This section provides a short overview of Industrial Technology and Engineering. To narrow the focus from the larger institutions discussed in the previous section to the specific disciplines involved in this study, a brief description of the programs is provided.
Industrial Technology

Industrial Technology is a relatively young discipline compared to engineering. Industrial Technology has a unique history that can be traced back to Manual Arts, Manual Training, Industrial Education, and Industrial Arts (NAIT Homepage, 2000). The need for an Industrial Technology program derived from significant world events after World War II that resulted in a need for a more technology-oriented, highly skilled workforce (Keith & Talbott, 1991). For example, the first satellite in space launched by the Russians, Sputnik, was the catalyst for the National Defense Education Act in 1958. This spurred American educators to turn their attention to science as well as technology as part of a major school reform movement.

At the time of this study, there were 61 NAIT accredited programs at the associate and baccalaureate degree level in the United States (NAIT Baccalaureate Program Directory, 2000).

Engineering

Engineering can be traced back to as early as 500,000 B.C. (Garrison, 1991). Some believe that this field of study is as old as civilization itself (Finch, 1951), and certainly is perceived by many to be the backbone of human accomplishments for western civilization (Finch, 1951). The evolution of engineering during the 20th century spun off many subdisciplines, such as aerospace, petroleum, transportation, nuclear, environmental, industrial, chemical, electrical, manufacturing, mechanical, and computer engineering.
Today, engineering programs are a part of most universities. The Accreditation Board of Engineering and Technology (ABET) maintains standards and provides certification for people in the discipline.

Student enrollment increased for all minority groups in 1997-98 for engineering except for African Americans. In the fall of 1998, there were 223,068 white students enrolled in engineering compared to 22,695 African Americans; and of HCBUs' engineering programs that are recognized by (ABET), the total enrollment was 6,190 African Americans (Dundee Holt, personal communication, November 4, 2000). In 1998, The National Action Council for Minorities in Engineering (NACME) reported that in 1996-97, African American freshman enrollment dropped 1.1 percent from 7,482 to 7,403 in 1997-98. Since 1992 (high of 8,924), there has been a 17 percent drop in enrollment (NACME, 1998). The Latino population increased from 5,467 to 5,858 in 1997-98. In 1997-98, the population of Native Americans went from 598 to 668, an 11.7 percent increase.

Summary

In summary, the purpose of this review of the literature was to provide a foundation for the reader to understand the very often complex issues concerning the study of learning styles, specifically, among marginal groups. A review of the research revealed some useful findings as well as discrepancies.

One of these discrepancies pertained to the terminology used when discussing learning styles. It was discovered that major confusion existed with respect to the overlapping definitions used to delineate between learning and cognitive styles. Some researchers and authors tend to use both terms interchangeably even though both concepts
have very different meanings. In addition, instruments used to measure the various aspects of learning among individuals also tended to be misused. Instruments that were designed to measure cognitive ability were sometimes used to determine learning style and vice versa.

This review of the literature generated a conviction that the educational environment along with the home environment has tremendous impact on how individuals learn. Kolb’s (1981) research, which examines learning styles of students in various disciplines, indicates that undergraduate education is an important factor in shaping the learning styles of students. With this said, it is imperative that educators try to unravel what it is about long-term exposure to a particular learning environment that shapes learning patterns and molds performance.

The topics discussed in this literature review clarify the need to produce additional scholarship that is conducted with rigor and precision. It is certain that implementing findings based on hurried and/or shallow research leads to skepticism and opposition. Given all that we know about teaching and learning and given all that we are learning about how the brain functions, now is an opportune time for further investigation into the study of learning styles. This testimony will add important information to the existing and growing body of knowledge pertaining to learning styles among minority groups within technical programs.
CHAPTER 3. METHODOLOGY

This chapter describes the methods and procedures used to establish the learning style preferences of students in Industrial Technology and Engineering at two land-grant institutions. Detailed are 1) Research Design, 2) Population and Sample, 3) Study Approvals, 4) Instrumentation, 5) Data Collection Procedures, 6) Description of Analyses, and 7) Procedures for Analyzing Data.

Research Design

This study utilizes a correlational and quasi-experimental design. The rationale for using this research design was to characterize subjects according to their learning style preferences using 20 elements (in the PEPS manual, please note learning styles are referred to as elements) to examine the independent variables. The independent variables for this study were 1) institution type (doctoral/research-extensive vs. master comprehensive I), 2) discipline (Industrial Technology and Engineering), and 3) ethnicity (African American and European American).

The dependent variables consisted of the 20 elements (learning styles) on the PEPS: light, afternoon, requires intake, learning/working in morning/evening, warmth, sound, learning alone/learn with others, late morning, mobility, auditory, design, responsible (conforming), structure, visual, kinesthetic, several ways, motivation/unmotivated, persistence, tactile, and authority figures. Measurements on each of the elements were recorded for each sampled student.
Population and Sample

The population used in this study consists of undergraduate students in Industrial Technology and Engineering programs at Iowa State University and at North Carolina A&T State University. The criteria for selecting the institutions for the study were based on their student characteristics and because these two land-grant institutions each offered accredited Industrial Technology and Engineering programs. One institution, NCAT, represents a large number of African American students while the other, ISU, has a majority of European American students.

Institutional characteristics

This study was conducted at Iowa State University's Department of Industrial Education and Technology and College of Engineering, and North Carolina A&T State University School of Technology and College of Engineering.

Iowa State University is a land-grant institution located in Ames, Iowa. Iowa State University is classified as Doctoral/Research Universities-Extensive under the Carnegie Classification system of universities. Such institutions offer a wide range of baccalaureate programs and award 50 or more doctoral degrees each year (Carnegie Classification, 2000). ISU's student enrollment is approximately 84 percent European American. In the fall semester of 2000, the undergraduate enrollment was 25,088 students (Office of the Registrar, 2001).

In the spring semester 2000, the Industrial Education and Technology Department's enrollment was 184 undergraduates (Office of the Registrar, 2001). This program is NAIT-accredited (NAIT Program Directory, 2000).
The total undergraduate enrollment is 4,072 students in the College of Engineering at Iowa State University (Office of the Registrar, 2001). The College of Engineering has eight ABET accredited engineering programs.

North Carolina A&T State University is a land-grant HBCU in Greensboro, North Carolina. North Carolina A&T State University is classified as a Master’s Comprehensive University I because it awards 40 or more master’s degrees each year in three or more disciplines (Carnegie Classification, 1994). In the fall of 2000, North Carolina A&T State University enrolled approximately 6,850 undergraduate students (Office of Institutional Research and Planning, 2000).

In the fall of 2000, total enrollment in North Carolina A&T State University’s School of Technology was 851 undergraduates (Office of Institutional Research and Planning, 2000). The Industrial Technology program at the School of Technology is NAIT-accredited (NAIT Program Baccalaureate Directory, 2000).

In the same semester, the College of Engineering at North Carolina A&T University enrolled 1,163 undergraduate students (Office of Institutional Research and Planning, 2000). There are seven ABET accredited programs in the College of Engineering.

Sample

This section provides a description of the sampling method used in the study and the sample size collected at the Department of Industrial Education and Technology and College of Engineering at Iowa State University, and the School of Technology and College of Engineering at North Carolina A&T State University.
Convenience sampling was used to ensure voluntary participation in Industrial Technology and Engineering at the two institutions. Convenience sampling is a nonprobability sampling technique that may have some drawbacks. McMillan and Schumacher (1997) explain that,

First, there is no precise way of generalizing from the sample to any type of population. This means that the generalizability of the findings will be limited to the characteristics of the subjects. This does not mean that the findings are not useful; it simply means that caution is needed in generalizing. (p. 169)

They further explain that,

The primary purpose of the research may not be to generalize but to better understand relationships that may exist . . . In this case, it may not be necessary to use probability sampling . . . The decision is not to dismiss the findings, but to limit them to the type of subjects in the sample. As more research accumulates with different convenient samples, the overall credibility of the results is enhanced. (pp. 169-171)

The accessibility of the students was important in order to achieve a high sample size to conduct a multivariate (factor) analysis. The subjects in the two programs meet the criteria of students needed that are European American and African American. Both institutions had a large sample of the ethnic groups needed to conduct the analysis and answer the research questions in the study.

Sample size equations indicated the need for a participant pool equal to 604 persons (Isaac & Michael, 1995). However, the actual sample size used for this study was equal to 540 persons. Though lower than the recommended sample size, this number does satisfy the requirements needed to run a factor analysis. See Table 1 for sample sizes in Industrial Technology and Engineering programs at ISU and NCAT.
Table 1. Sample sizes from Industrial Technology and Engineering programs at North Carolina A&T State University and Iowa State University

<table>
<thead>
<tr>
<th>School classification</th>
<th>NCAT</th>
<th>ISU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>IT</td>
<td>ENG</td>
</tr>
<tr>
<td>Freshman</td>
<td>24</td>
<td>22</td>
</tr>
<tr>
<td>Sophomore</td>
<td>29</td>
<td>38</td>
</tr>
<tr>
<td>Junior</td>
<td>32</td>
<td>38</td>
</tr>
<tr>
<td>Senior</td>
<td>46</td>
<td>43</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
<td>136</td>
</tr>
</tbody>
</table>

Study Approvals

Before the data were collected, contact was made in December and January with the Department of Industrial Education and Technology, Colleges of Engineering, and School of Technology at the two institutions to provide the administrators with (Deans and Department Chairperson) information about the proposed study and invite their participation. Conversations with administrators confirmed that conducting the study was possible upon approval by the doctoral committee at Iowa State University. Permission to conduct the study was granted by the Human Subject Committees at the two universities (see Appendix A) and by the researcher’s doctoral committee. After approval from Human Subjects Committees and the doctoral committee, official letters seeking permission from the participation sites were sent to each institution. These are provided in Appendix B. In addition, permission was requested and received from the developer of the PEPS to use this survey for the study (see Appendix C). Data collection occurred March and April during the spring 2001 semester.
Instrumentation

In Chapter 2, the literature review provided a description of the Productivity Environmental Preference Survey (PEPS). Curry’s Onion Model classified this instrument as an “Instructional Preference” instrument. PEPS is an instrument that focuses on the learning environment. In this section, the limitations and benefits of the PEPS are highlighted, as well as the rationale for selecting the instrument, a description of the instrument, disciplines who uses PEPS, and the reliability and validity of the instrument.

Benefits and limitations

Careful selection of an instrument requires evaluating its benefits and limitations. Information enables the investigator to make a decision whether or not to use a particular instrument. Phone interviews and reviews were conducted to inquire about the quality of the PEPS instrument.

Sippola (1992) explained that “the physical variables have face validity; temperature, noise/sound levels, lighting levels, and amount of formal structure (possibly even time of day) are all standard variables discussed in the environment and behavior literature” (p. 705). Sippola (1992) suggests that “it could be an interesting component of a research program that could include both environmental assessment and performance/productivity measures as outcome criteria” (p. 705).

The limitations of the PEPS according to the Eleventh Mental Measurements Yearbook, (1992) pertain to validity problems. However, researchers still use the PEPS to obtain preferred learning styles of students. According to Sippola (1992), the instrument does not measure hidden psychological motivation. Sippola (1992) notes that the PEPS and the
Learning Style Inventory (LSI), both based on the Dunn and Dunn Learning Style Model, focus on the “importance of the empirical development of their instruments using content and item analysis and factor analytic studies” (p. 704). Dr. Price and others continue to defend their position on the issue of validity. Between these authors and the reviewers, there may be some confusion or misunderstanding over the theoretical framework used to develop learning style instruments.

Rationale for selecting instrument

The rationale to use the PEPS is based on some background literature and reviews from the 1992 Mental Measurements Yearbook. There are eight reasons for selecting this instrument: 1) the instrument closely aligns with Keefe’s (1987) definition of “learning style”; 2) the instrument is widely used; 3) the closest instrument (Canfield Learning Style) that is similar has poor reliability and no validity established according to the 1992 Mental Measurement Yearbook; 4) there is no parallel instrument that would enable establishing concurrent validity; 5) the instrument is designed for adults which the sample is comprised of; 6) the instrument is widely used; and 7) there is opportunity for extending use of the Dunn and Dunn Learning Style Model to Engineering and to African American college students.

Description of selected instrument

According to Price (1996), the PEPS inventory is the first comprehensive approach used to identify learning styles of adults. In addition, this inventory is useful in examining
adult productivity. The PEPS consists of a 100 statement survey that is administered by paper, computer, or orally. This study employed the paper version.

The questions are answered on an interval scale with numerical values that yield a quantitative score. A five-point Likert Scale, with choices ranging from least preferred to strongly preferred, is used to assess a student’s learning style preference. Students are encouraged to select the first response to each question as if they were learning something new. There are 20 learning style elements in the inventory and Appendix D provides their descriptions. The standard scores range from 20 to 80 with a mean of 50. Students who score 40 or less were “least preferred” or 60 or more were “most preferred,” indicating that the student prefers a style that benefits them when they work or study. A standard deviation of 10 was derived from a random sample of 1000 subjects selected from a national database for those who have taken the PEPS (Price, 1996). According to Dunn and Griggs (2000), the PEPS has been “used extensively in published studies that examine adult learning styles” (p. 13).

PEPS has had widespread use in various professions and education disciplines such as court reporting (Coolidge-Parker, 1989), nursing (Garcia-Otero & Teddlie, 1992), and personnel and management (Peeples, 1979). It has also been used to investigate ethnic differences (Lam-Phoon, 1986), instructional methodology (Gunita, 1984), and study skills of college students (Clark-Thayer, 1987). Craig Mills, from the GRE Testing Services, reviewed this survey and found that it had been used to conduct studies with undergraduate, graduate students, and in industry (The Eleventh Mental Measurements Yearbook, 1992).
Reliability and validity

Since 1986 there have been many efforts to improve the PEPS. Price (1996) noted that there were 504 subjects who were used in a study on January 8, 1996 to establish reliability (p. 40). The PEPS was revised by Price (1996) in which he carefully reviewed each element. The reliabilities for the PEPS were 90 percent equal or greater than .60. The elements with the highest reliabilities are 1) light .91, 2) afternoon .88, 3) requires intake .88, 4) learning/working in morning/evening (time of day) .87, 5) warmth .86, 6) sound .86, 7) learning alone/learn with others .86, 8) late morning .84, 9) mobility .83, 10) auditory .81, 11) design .76, 12) responsible (conforming) .76, 13) structure .71, 14) visual .71, 15) kinesthetic .67, 16) several ways .67, 17) motivation/unmotivated .65, and 18) persistent .63. The elements with the lowest reliabilities were tactile .33 and authority figures present .48. According to Bertram Sippola, a reviewer of the PEPS, the reliabilities reported are satisfactory (The Eleventh Mental Measurements Yearbook, 1992).

Data Collection Procedures

This section discusses the data collection procedures for both disciplines at the two institutions.

Data collection procedures for North Carolina A&T State University

A memo was e-mailed to students in Industrial Technology and Engineering to ensure everyone was informed. The administrators from the School of Technology and College of Engineering at North Carolina A&T State University provided administrative support by setting up a room for the data collection.
This investigator traveled to North Carolina A&T State University to administer the survey at the College of Engineering during March 12-15, 2001. At the School of Technology, the survey was administered on March 13-15. The investigator was present from 8:00 a.m. to 5:00 p.m. on those days for students to take the survey. A range of times was provided for students to take the survey to ensure that students from different sub-disciplines and school classifications were not excluded because of scheduling.

Before administering the survey, an explanation of the purpose of the study was provided as well as restating the directions to follow when completing the Scantron sheet. The students were asked to identify their ethnicity. The students usually took between 20 to 30 minutes to complete the survey.

**Data collection procedures for Iowa State University**

In the Industrial Education & Technology Department, students were contacted by e-mail three weeks in advance to inform them of the upcoming study. Memos were written to explain to faculty and students the purpose of the study, to guarantee confidentiality, and to explain the nature of the instrument. Faculty were asked to verbally remind the students in their classes.

The surveys were administered on March 28th from 4:30 p.m. to 5:30 p.m., March 29th from 12:00 noon to 1:00 p.m., and on April 2nd from 1:00 p.m. to 2:00 p.m. All data collection was done in the student lounge at the Industrial Education & Technology Department. The academic advisor provided a list of names of students who were enrolled in the department. Once the survey processing began, each student's name was checked off to
ensure that no student would take the survey twice. Students took between 20 to 30 minutes to complete the instrument.

In ISU’s College of Engineering, the Manager of Undergraduate Programs assisted the investigator in e-mailing students and engineering organizations to solicit participation in the study. Dates and times established for this study were March 26th from 6:00 to 7:00 p.m., March 27-28 from 12:00 p.m. to 1:00 p.m., 6:00 p.m. to 7:00 p.m., and March 29th from 7:00 p.m. to 8:00 p.m. All engineering students were given the same instructions for filling out the demographic information and survey form as were the industrial technology students.

Once the surveys were collected, the appropriate institution, college/school, and department code was applied to each survey (e.g., 00=ISU ITEC). These were then sent to Price Systems Inc., in Lawrence, Kansas, for scoring. Price Systems, Inc., the developer of the instrument, calculated the raw and standard scores indicating each student’s learning style preference. Each individual’s preferred learning style profile was returned to the investigator on hardcopy sheets and on disk. The data file was prepared in a spreadsheet format enabling import into the Statistical Package for the Social Sciences (SPSS®) used for subsequent analysis.

**Description of Analyses**

The analytical methodology used for this study is an exploratory factor analysis and discriminant analysis. The assumptions of the analyses are presented in this section.
Factor analysis

Exploratory factor analysis was used to determine how the learning style elements clustered. The reason for using factor analysis for this study is to (1) reduce the number of variables, i.e., to select a subset of variables from a larger set, and (2) identify clusters of cases and correlations of the clusters. Exploratory factor analysis is used when there is no prior knowledge of the factor structures. Furthermore, exploratory factor analysis determines the number of common factors that exist in a set of observed or latent variables through their shared correlations (Kim & Mueller, 1978).

According to Dillon and Goldstien (1984), factor analysis can be used as a data reduction technique. The factors resulting from the factor loading can be viewed as major learning styles themselves. In essence, complex and diverse relationships are simplified and made more robust. This technique uses the interrelationships of variables to create a smaller set of variables. The new set of variables is usually comprised of fewer numbers than the original variables in the set.

A varimax rotation was used as an orthogonal rotation technique to create simple structures. The reason for using the varimax rotation/orthogonal method is to maximize the variance of the loadings and to minimize cross loadings of items that may load on more than one factor. This method also allows for the option to exclude items.

Data requirements essential to the assumptions for the factor analysis help guide the investigator as to whether or not to use this particular analysis. The assumptions for a factor analysis (Garson, 2001, p. 8) include:
- **No selection bias/proper specification.** The exclusion of relevant variables and the inclusion of irrelevant variables in the correlation matrix being factored may affect the factors that are uncovered.

- **Linearity.** Note that principal component factor analysis is a linear procedure. Furthermore, the smaller the sample size, the more carefully the data have to be screened for linearity.

- **Multivariate normality.** Principal component factor analysis and significance testing apart has no distribution assumptions. Note, however, that a less-used variant of factor analysis, maximum likelihood factor analysis, does not assume multivariate normality. Again, the smaller the sample size, the more important it is to screen for normality.

- **Orthogonality.** The unique factors should be uncorrelated with each other or common factors.

- **Underlying dimensions.** They are shared by clusters of variables (factor analysis cannot create valid dimensions [factors] if none exist in the input data).

- **Moderate to moderate-high intercorrelations.** While intercorrelations are not mathematically required, applying factor analysis to a correlation matrix with only low intercorrelations will yield a solution with nearly as many principal components as there are original variables, thereby defeating the data reduction purposes of factor analysis.

- **Factor interpretation and labels.** Labels must have face validity or be rooted in theory.
Discriminant analysis/Box's M Test

To ascertain the difference between the groups (e.g., Industrial Technology and Engineering) an analysis was needed to test the hypothesis. Discriminant analysis classifies known groups. The Box’s M Test within discriminant analysis is used to examine the homogeneity of covariance among subscales. This also determines whether or not there is a statistical difference between groups.

Data requirements for the assumptions for using discriminant analysis guide the investigator as to whether or not to use this analysis. The assumptions for the discriminant analysis (Stevens, 1986, p. 205) include:

- The observations on the \( p \) dependent variables follow a multivariate normal distribution in each group (Normal Distribution). Any linear combination of the variables is normally distributed and all other subsets of the set of variables will have a multivariate normal distribution.
- The population covariance matrices for the \( p \) dependent variables in each group are equal. (Homogeneity of Variances/Covariances)
- The observations are independent.

Procedures for Analyzing Data

The overall procedures involved analyzing the data in three steps. These included:

1. Conducting a factor analysis for the independent variables of ethnicity and discipline for each institution.
2. Developing a “Decision Rule.” The purpose of the “Decision Rule” is to eliminate variables that have confused loadings.
3. Testing all hypotheses. The Box’ M Test from the discriminant analysis procedure was used for this purpose.

All statistical tests conducted were tested at the \textit{a priori} alpha level of .05 because this level of significance is commonly used for research in education.

**Null Hypothesis 1**

There is no difference between the factor loading profiles of the learning styles on the PEPS with African American Industrial Technology and Engineering students at NCAT and European American Industrial Technology and Engineering students at ISU.

**Null Hypothesis 2**

There is no difference between the factor loading profiles of the learning styles on the PEPS for African American students enrolled in Industrial Technology, when compared with African American students enrolled in Engineering at North Carolina A&T State University.

**Null Hypothesis 3**

There is no difference between the factor loading profiles of the learning styles on the PEPS for European American students in Industrial Technology when compared with European American students enrolled in Engineering at Iowa State University.

In summary, this section provides a description of the methodology and statistical analysis used for this study. The two major analyses included an exploratory factor analysis
and the Box’s M Test from a discriminant analysis. This chapter also reviewed the data
collection procedures used and a detailed description of the target population. And finally, an
in-depth description was provided of the instrumentation used to collect the information.
CHAPTER 4. FINDINGS

The purpose of this study was to examine the preferred learning style preferences of Industrial Technology and Engineering students at Iowa State University and North Carolina A&T State University. This chapter reports the description and analysis of the collected data. It also provides a description of the sample used in the study and a normality check for the factor scores of the groups (e.g., European American students) used in the factor analysis. Subsequently, this chapter provides inferential statistics to answer the three hypotheses posed in this study. All data were analyzed using SPSS® for Windows (Release 10.0). Results are displayed separately for each hypothesis.

Description of the Sample

The initial sample consisted of 540 subjects. After the data were collected and tabulated, the researcher noted one missing and three erroneous data points on the spreadsheet provided by the scoring service. These were eliminated, leaving 536 subjects in the usable sample.

Data were examined by gender and ethnicity in each subdiscipline and institution. Table 2 shows the number of students in the total sample by gender in each of their respective department, school, and colleges. Table 3 shows the African American and European American students in their respective department, school, and college. Only the African American students at North Carolina A&T State University and European American students at Iowa State University were used in the statistical analysis. Table 4 identifies the subdisciplines of the usable sample in each institution.
Table 2. Sample size of students by gender for North Carolina A&T State University (NCAT) and Iowa State University (ISU)

<table>
<thead>
<tr>
<th>Gender</th>
<th>NCAT</th>
<th>ISU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>92</td>
<td>129</td>
<td>382</td>
</tr>
<tr>
<td>Female</td>
<td>39</td>
<td>6</td>
<td>154</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
<td>135</td>
<td>536</td>
</tr>
</tbody>
</table>

Table 3. Sample size of African American and European American students at NCAT and ISU by department and school/college

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>NCAT</th>
<th>ISU</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>129</td>
<td>3</td>
</tr>
<tr>
<td>European American</td>
<td>0</td>
<td>127</td>
</tr>
<tr>
<td>Total</td>
<td>129</td>
<td>130</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Eng</th>
<th>Eng</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>128</td>
<td>2</td>
</tr>
<tr>
<td>European American</td>
<td>5</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td>129</td>
<td>124</td>
</tr>
</tbody>
</table>
Table 4. Sample size of students according to subdiscipline at NCAT and ISU

<table>
<thead>
<tr>
<th>Subdiscipline</th>
<th>NCAT</th>
<th>ISU</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Itec</td>
<td>Eng</td>
</tr>
<tr>
<td>Man Itec</td>
<td>45</td>
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</tr>
<tr>
<td>Os Itec</td>
<td>5</td>
<td>--</td>
</tr>
<tr>
<td>Trd Itec</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Grps Itec</td>
<td>15</td>
<td>--</td>
</tr>
<tr>
<td>Elecom Itec</td>
<td>65</td>
<td>--</td>
</tr>
<tr>
<td>Conmgt Itec</td>
<td>1</td>
<td>--</td>
</tr>
<tr>
<td>Civil Eng</td>
<td>--</td>
<td>4</td>
</tr>
<tr>
<td>Man Eng</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>Chem Eng</td>
<td>--</td>
<td>12</td>
</tr>
<tr>
<td>Indus Eng</td>
<td>--</td>
<td>19</td>
</tr>
<tr>
<td>Mech Eng</td>
<td>--</td>
<td>16</td>
</tr>
<tr>
<td>Arch Eng</td>
<td>--</td>
<td>14</td>
</tr>
<tr>
<td>Comp Eng</td>
<td>--</td>
<td>17</td>
</tr>
<tr>
<td>Ag Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Aero Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Cer Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Engsci Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Met Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Elec Eng</td>
<td>--</td>
<td>53</td>
</tr>
<tr>
<td>Cons Eng</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>131</td>
<td>136</td>
</tr>
</tbody>
</table>

Normality Check

In order to check for normality of the factor scores, a factor analysis was performed on the entire sample to determine how items clustered around a common factor. This is typical for factor analysis. The factor analysis reduced the original 20 learning styles to six factors. The six factors were not named due to the factor scores being examined only for normality. Within the factor analysis program, the Anderson-Rubin technique (SPSS, 1999) produced z-scores in each factor(s). This technique creates random standardized normal distribution (variables/z-scores) where the mean is 0 and the standard deviation is 1 (Harman, 1976). Therefore, the resulting values are expressed in how many standard deviations that a particular observation is away from the mean of 0. For example, a value of -1.5 indicates that the particular observation has a factor score that is 1.5 standard deviations below the average. To check for normality of the distribution of the factor scores, the z-scores were used to produce frequency histograms for each factor. This was to illustrate the shape of the distribution and to provide insight on the feasibility of the analysis.

The histograms illustrated three extreme outliers that skewed the data. Before the outliers were removed, the identification numbers of the surveys were checked. The identification numbers confirmed a "consistent" pattern of bubble fill-ins. Subsequently, the three extreme data points were removed. This is known as "data conditioning." The 20 learning styles were reloaded into the factor analysis.

After repeating the above procedures, the new factor loadings increased to eight. The values for kurtosis and skewness were deemed acceptable within the test for normality. According to Douglas Bonett, a Statistics and Psychology Professor at Iowa State University, the size of the sample was large enough and the skewness and kurtosis values were small.
enough to allow the use of the analysis (personal communication, May 10, 2001). He indicated that skewness values from \(-.5\) to \(+.5\) and kurtosis values from \(-1\) to \(+1\) would not be a problem given the large sample size. The histograms were obtained to verify normality of the distribution. Skewness and kurtosis were at acceptable values to indicate normality of the distribution for both European American and African American students. See Figures F.1 and F.2 in Appendix F.

**Data Analysis**

In this section, the hypotheses were tested by using inferential statistics in two steps. The first step was to use a factor analysis to reduce the 20 elements to a smaller number of variables. There were 20 elements that were factor analyzed using a sample size of 536 participants. The second step involved running a Box’s M Test to determine if any significant difference exists between groups.

**Factor analysis**

The standard scores from the PEPS 20 elements for each group (e.g., industrial technology) were used for the factor analysis. The factors were generated by an orthogonal rotation. Confused variables were removed from the analysis. Confused loading occurs when any variable loads on more than one factor with acceptable loadings. An example of the confused loading for light is provided below:

<table>
<thead>
<tr>
<th>Learning style</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIGHT</td>
<td>.288</td>
<td>-.0278</td>
<td>.295</td>
<td>-.272</td>
<td>-.473</td>
<td>-.0438</td>
<td>361</td>
</tr>
</tbody>
</table>
Loadings with scores of negative and positive values tend to be less clear. The factor loading profiles should have “pure” or “simple structure” in terms of the high correlation with other variables. When confused loading patterns were present in the variables (learning styles), they were removed from the factor structure.

Selecting the factors that are “pure” was somewhat subjective; one must decide which factors to remove and which variables to leave remaining in the models. To help select the purest factors, the investigator developed a decision rule to assist in systematically excluding confused variables.

- If a variable’s score is .3 or less and/or double loading occurs, remove the variable.
- If variables have a positive loading in one factor and the other factor has a negative loading, remove the variable.

A factor analysis produced structures in which variables were arranged from the strongest to the weakest. The strongest loadings always occur in the first factor. Within each factor, each variable’s scores were sorted from highest to lowest. To illustrate this point, the first factor’s total variance accounts for an amount greater than the other factors, at least 60 percent of the total variance (Kim & Mueller, 1978). The first factor loadings are italicized for each set of structures. Each factor structure was given a label based on the characteristics of the variables.

The first variable (learning style) listed in each of the first factor loading profile had the highest factor score and was, therefore, considered the “most influential” learning style in that factor.
Discriminant analysis/Box’s M Test

The hypotheses were tested by the Box’s M test in the discriminant analysis. The hypotheses were tested at an *a priori* level of .05 to ascertain significant differences in the factor structures or groups.

Null Hypothesis 1

There is no difference between the factor loading profiles of the learning styles on the PEPS for African American Industrial Technology and Engineering students at NCAT and European American Industrial Technology and Engineering students at ISU.

Hypothesis 1 test results

The first null hypothesis was tested to ascertain whether differences existed between the factor structures for African American and European American. A discriminant analysis was conducted to test the hypothesis. The Box’s M Test revealed that the two factor structures were significantly different, $F(210, 774761.5) = 262.708, p = .025$.

Eight factors were identified with eigenvalues greater than 1.00. Together these explained 66.6 percent of the total variance in the factor structure for African American students. Factor One’s top three learning styles accounted for 33.5 percent of the total variance in the factor loading profile. Five learning styles were removed from the factor structure because of confused loading. The first learning style (motivation) in Factor One accounted for 13.4 percent of the variance.
The first factor loading profile for African American students showed motivation (.789), persistent (.719), and kinesthetic (.643) as the top three learning style preferences. Table 5 provides the factor analysis results and Table 6 provides the names for the factors.

Table 5. Factor loading profiles for African Americans at NCAT

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Motivation</td>
<td>.789</td>
</tr>
<tr>
<td>Persistent</td>
<td>.719</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>.643</td>
</tr>
<tr>
<td>Afternoon</td>
<td>--</td>
</tr>
<tr>
<td>Late Morning</td>
<td>--</td>
</tr>
<tr>
<td>Time of Day (Evening/Morning)</td>
<td>--</td>
</tr>
<tr>
<td>Alone/Peers</td>
<td>--</td>
</tr>
<tr>
<td>Several Ways</td>
<td>--</td>
</tr>
<tr>
<td>Auditory</td>
<td>--</td>
</tr>
<tr>
<td>Structure</td>
<td>--</td>
</tr>
<tr>
<td>Design</td>
<td>--</td>
</tr>
<tr>
<td>Temperature</td>
<td>--</td>
</tr>
<tr>
<td>Authority Figure</td>
<td>--</td>
</tr>
<tr>
<td>Mobility</td>
<td>--</td>
</tr>
<tr>
<td>Visual</td>
<td>--</td>
</tr>
</tbody>
</table>

*Note.* Factor loading score that is bold is the "most influential" learning style.

*African American students are included in both disciplines at the NCAT.*
Table 6. Names for factors of African Americans at NCAT

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physically Involved /Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Social Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Detail by Listening Oriented Learner</td>
</tr>
<tr>
<td>5</td>
<td>Environmental/No-time Out Learner</td>
</tr>
<tr>
<td>6</td>
<td>Attitudinal/Dependent Learner</td>
</tr>
<tr>
<td>7</td>
<td>Movement Oriented</td>
</tr>
<tr>
<td>8</td>
<td>Sight Oriented Learner</td>
</tr>
</tbody>
</table>

In the factor structure for European Americans, seven factors were identified with eigenvalues greater than 1.00. Together they explained 64.5 percent of the total variance in the factor structure for European American students. Two learning styles were removed from the factor structure because of confused loading. In Factor One, the three variables together accounted for 34.3 percent of the total variance for the factor loading profile. The first learning style (responsible) in Factor One accounted for 12 percent of the total variance.

The first factor loading profile in the factor structure revealed responsible (.801), motivation (.703), and persistent (.694) as the top three learning style preferences. Table 7 provides the factor analysis results and Table 8 provides names for the factors. Table 9 provides an overall comparison of the first factor loading profiles in the factor structures.
Table 7. Factor loading profiles for European Americans at ISU\(^a\)

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Responsible</td>
<td>.801</td>
</tr>
<tr>
<td>Motivation</td>
<td>.703</td>
</tr>
<tr>
<td>Persistent</td>
<td>.694</td>
</tr>
<tr>
<td>Afternoon</td>
<td></td>
</tr>
<tr>
<td>Late Morning</td>
<td></td>
</tr>
<tr>
<td>Time of Day (Evening/Morning)</td>
<td></td>
</tr>
<tr>
<td>Authority Figure</td>
<td></td>
</tr>
<tr>
<td>Tactile</td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td></td>
</tr>
<tr>
<td>Kinesthetic</td>
<td></td>
</tr>
<tr>
<td>Several Ways</td>
<td></td>
</tr>
<tr>
<td>Alone/Peers</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td></td>
</tr>
<tr>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td>Auditory</td>
<td></td>
</tr>
<tr>
<td>Visual</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Factor loading score that is bold is the “most influential” learning style.

\(^a\)European American students are included in both disciplines at ISU.
Table 8. Names for factors of European Americans at ISU

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complex/ Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Hands-on/Coached Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Environmental/No-time Out Learner</td>
</tr>
<tr>
<td>5</td>
<td>&quot;Soft&quot; Environmental/ Learner</td>
</tr>
<tr>
<td>6</td>
<td>Hear/Sight Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Climate Oriented Learner</td>
</tr>
</tbody>
</table>

Table 9. A comparison of the first factor loading profiles by ethnicity at NCAT and ISU

<table>
<thead>
<tr>
<th>African American</th>
<th>European American</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Responsibility</td>
</tr>
<tr>
<td>Persistent</td>
<td>Motivation</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>Persistent</td>
</tr>
</tbody>
</table>

**Null Hypothesis 2**

There is no difference between the factor loading profiles of the learning styles on the PEPS for students enrolled in Industrial Technology, when compared with African American students enrolled in Engineering at North Carolina A&T State University.

**Hypothesis 2 test results**

The second null hypothesis employed a discriminant analysis to test for the factor structures of African Americans in Industrial Technology and Engineering at NCAT. Box's
M Test revealed that the two factor structures were not significantly different, \( F (210, 198706.1) = 234.430, p = .385. \)

Eight factors were identified with eigenvalues above 1.00. Together, they explained 68.4 percent of the total variance in the factor structure for students in Industrial Technology at North Carolina A&T State University. Three learning styles were removed from the factor structure because of confused loading. Factor One’s top three variables combined accounted for 33.7 percent of the total variance for the factor loading profile. The first learning style (motivation) in Factor One accounted for 13.9 percent of the total variance. The first factor loading profile for Industrial Technology students showed motivation (.802), persistent (.774), and kinesthetic (.736) were the top three learning style preferences. Table 10 provides the factor analysis results and Table 11 provides the names of the factors that were to explain the factor structure.

In the factor structure for Engineering students at NCAT, eight factors were identified with eigenvalues greater than 1.00. Together, they explained 68.5 percent of the total variance in the factor structure. Three learning styles were removed from the factor structure because of confused loading. Factor One’s combined top three learning styles accounted for 32.9 percent of the total variance in the factor loading profile. The first learning style in Factor One accounted for 12.2 percent of the total variance. Factor One revealed these learning style preferences for Engineering students: motivation (.739), responsible (.753), and persistent (.700). Table 12 provides the factor analysis results and Table 13 provides the names of the factors that explain the factor structure.
Table 10. Factor loading profiles for Industrial Technology students at NCAT

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>Motivation</strong></td>
<td>.802</td>
</tr>
<tr>
<td><strong>Persistent</strong></td>
<td>.774</td>
</tr>
<tr>
<td><strong>Kinesthetic</strong></td>
<td>.736</td>
</tr>
<tr>
<td><strong>Afternoon</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Late Morning</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Time of Day</strong></td>
<td>-</td>
</tr>
<tr>
<td>(Evening/Morning)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Alone/Peers</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Several Ways</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Design</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Intake</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Auditory</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Responsible</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Authority Figure</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Visual</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td>-</td>
</tr>
</tbody>
</table>

*Note.* Factor loading score that is bold is the "most influential" learning style.
Table 11. Names for factors of Industrial Technology students at NCAT

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hands-on/Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Nonsocial/Climate Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Environmental/No-time Out Learner</td>
</tr>
<tr>
<td>5</td>
<td>Independent/Detailed/Listener Learner</td>
</tr>
<tr>
<td>6</td>
<td>Reassurance Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Sight Oriented Learner</td>
</tr>
<tr>
<td>8</td>
<td>Movement Oriented</td>
</tr>
</tbody>
</table>
Table 12. Factor loading profiles for Engineering students at NCAT

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Motivation</td>
<td>.789</td>
</tr>
<tr>
<td>Responsible</td>
<td>.753</td>
</tr>
<tr>
<td>Persistent</td>
<td>.700</td>
</tr>
<tr>
<td>Afternoon</td>
<td>--</td>
</tr>
<tr>
<td>Late Morning</td>
<td>--</td>
</tr>
<tr>
<td>Time of Day</td>
<td>--</td>
</tr>
<tr>
<td>(Evening/Morning)</td>
<td></td>
</tr>
<tr>
<td>Alone/Peers</td>
<td>--</td>
</tr>
<tr>
<td>Several Ways</td>
<td>--</td>
</tr>
<tr>
<td>Temperature</td>
<td>--</td>
</tr>
<tr>
<td>Authority Figure</td>
<td>--</td>
</tr>
<tr>
<td>Tactile</td>
<td>--</td>
</tr>
<tr>
<td>Auditory</td>
<td>--</td>
</tr>
<tr>
<td>Structure</td>
<td>--</td>
</tr>
<tr>
<td>Intake</td>
<td>--</td>
</tr>
<tr>
<td>Light</td>
<td>--</td>
</tr>
<tr>
<td>Mobility</td>
<td>--</td>
</tr>
<tr>
<td>Visual</td>
<td>--</td>
</tr>
</tbody>
</table>

*Note. Factor loading score that is bold is the “most influential” learning style.*
Table 13. Names for factors of Engineering students at NCAT

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Complex/Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Social Oriented Learer</td>
</tr>
<tr>
<td>4</td>
<td>Balanced Oriented Learer</td>
</tr>
<tr>
<td>5</td>
<td>Detail by Listening Oriented Learner</td>
</tr>
<tr>
<td>6</td>
<td>Contentment Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Movement Oriented</td>
</tr>
<tr>
<td>8</td>
<td>Sight Oriented Learer</td>
</tr>
</tbody>
</table>

**Null Hypothesis 3**

There is no difference between the factor loading profiles of the learning styles on the PEPS for European American students in Industrial Technology when compared with students enrolled in Engineering at Iowa State University.

**Hypothesis 3 test results**

The third null hypothesis employed the discriminant analysis test for determining differences among the factor structures for European Americans in Industrial Technology and Engineering at ISU. Box’s M Test revealed that the two factor structures were not significantly different, $F (210, 184070.7) = 234.430, p = .263$.

In the ITEC student responses, eight factors were identified with eigenvalues greater than 1.00. Together, they explained 71 percent of the total variance in the factor structure for students in Industrial Technology at Iowa State University. One learning style was removed from the factor structure because of confused loading. Factor One’s top five learning styles
combined accounted for 51.9 percent of the total variance in the factor loading profile. The first learning style (motivation) in Factor One accounted for 13.8 percent of the total variance. Factor One revealed these learning style preferences in the factor loading profile: motivation (.790), persistent (.714), responsible (.711), kinesthetic (.701), and tactile (.510). Table 14 provides the factor analysis results and Table 15 provides the names of the factors that explain the factor structure.

For Engineering student responses, seven factors were identified with eigenvalues greater than 1.00. Together, they explained 66.8 percent of the total variance in the factor structure. Two learning styles were removed from the factor structure because of confused loading. The top three learning styles combined accounted for 35 percent of the total variance in the factor loading profile. The first learning style (authority figure) in Factor One accounted for 12.1 percent of the total variance. Factor One revealed authority figure (.715), kinesthetic (.701), and tactile (.660) as the learning style preferences for Engineering students. Table 16 provides the factor analysis results and Table 17 provides the names of the factors that explain the factor structure.

Additional findings

Although, there were no significant differences in the factor structures among Industrial Technology and Engineering students at either institution, there were visual component differences when comparing the Factor One loadings. When looking more closely at the factor structures for Industrial Technology and Engineering at both institutions, the Factor One loadings were different in learning style detail.
Table 14. Factor loading profiles for Industrial Technology students at ISU

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Motivation</td>
<td>..790</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Persistent</td>
<td>..714</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Responsible</td>
<td>..711</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>..701</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Tactile</td>
<td>..510</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Afternoon</td>
<td>--</td>
<td>-.938</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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</tr>
<tr>
<td>Late Morning</td>
<td>--</td>
<td>..854</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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</tr>
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<tr>
<td>(Evening/Morning)</td>
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<td></td>
</tr>
<tr>
<td>Alone/Peers</td>
<td>--</td>
<td>--</td>
<td>..875</td>
<td>--</td>
<td>--</td>
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</tr>
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<td>Several Ways</td>
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<td>--</td>
<td>-.847</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>-.722</td>
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<td>--</td>
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<td>--</td>
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<td>--</td>
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<td>--</td>
<td>--</td>
<td>..726</td>
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<td>--</td>
<td>..720</td>
<td>--</td>
<td>--</td>
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</tr>
<tr>
<td>Visual</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>..788</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Auditory</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-.735</td>
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</tr>
<tr>
<td>Temperature</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>..849</td>
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<tr>
<td>Mobility</td>
<td>--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>-.742</td>
</tr>
<tr>
<td>Noise</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>..589</td>
</tr>
</tbody>
</table>

*Note*. Factor loading score that is bold is the "most influential" learning style.
Table 15. Names for factors of Industrial Technology students at ISU

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hands-on/Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Social Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Environmental/Time-out Oriented Learner</td>
</tr>
<tr>
<td>5</td>
<td>Detailed/Oriented Learner</td>
</tr>
<tr>
<td>6</td>
<td>Hear/Sight Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Climate Oriented Learner</td>
</tr>
<tr>
<td>8</td>
<td>Sight Oriented Learner</td>
</tr>
</tbody>
</table>
Table 16. Factor loading profiles for Engineering students at ISU

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Authority Figure</td>
<td>.715</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>.701</td>
</tr>
<tr>
<td>Tactile</td>
<td>.660</td>
</tr>
<tr>
<td>Responsible</td>
<td>--</td>
</tr>
<tr>
<td>Persistent</td>
<td>--</td>
</tr>
<tr>
<td>Motivation</td>
<td>--</td>
</tr>
<tr>
<td>Afternoon</td>
<td>--</td>
</tr>
<tr>
<td>Late Morning</td>
<td>--</td>
</tr>
<tr>
<td>Time of Day</td>
<td>--</td>
</tr>
<tr>
<td>(Evening/Morning)</td>
<td></td>
</tr>
<tr>
<td>Several Ways</td>
<td>--</td>
</tr>
<tr>
<td>Alone/Peers</td>
<td>--</td>
</tr>
<tr>
<td>Visual</td>
<td>--</td>
</tr>
<tr>
<td>Auditory</td>
<td>--</td>
</tr>
<tr>
<td>Intake</td>
<td>--</td>
</tr>
<tr>
<td>Design</td>
<td>--</td>
</tr>
<tr>
<td>Light</td>
<td>--</td>
</tr>
<tr>
<td>Structure</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. Factor loading score that is bold is the “most influential” learning style.
Table 17. Names for factors of Engineering students at ISU

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hands-on/Collaborative Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Independent Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Social Oriented Learner</td>
</tr>
<tr>
<td>5</td>
<td>Autonomy/Social Oriented Learner</td>
</tr>
<tr>
<td>6</td>
<td>Perceptual Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Tranquil/Illumination Oriented Learner</td>
</tr>
</tbody>
</table>

Table 18 provides a summary comparison of the variables (learning style preferences) in the first factor loading profiles of African American students in Industrial Technology and Engineering at North Carolina A&T State University and European American students in the same two programs at Iowa State University. Table 19 provides an overall comparison of the learning styles in Factor One loadings for Industrial Technology and Engineering combined in each institution.

Because of the nature of the findings, additional analyses were conducted in an attempt to unveil underlying relationships. The researcher conducted a factor analysis for African American and European American students combined in Industrial Technology and Engineering to examine the factor loadings. In addition, the researcher ascertained if there was a significant difference between the two disciplines.

Eight factors were identified with eigenvalues greater than 1.00. Together they explained 67.2 percent of the total variance in the factor structures (regardless of ethnicity). Three learning styles were removed from the factor structure because of confused loading.
Table 18. The first factor loading profiles for African American preferred learning styles by discipline at NCAT and European American students at ISU

<table>
<thead>
<tr>
<th>Institutions</th>
<th>ISU</th>
<th>NCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Technology</td>
<td>Motivation Persistent Responsible Kinesthetic Tactile</td>
<td>Motivation Persistent Kinesthetic</td>
</tr>
<tr>
<td>Engineering</td>
<td>Authority figure Kinesthetic Tactile</td>
<td>Motivation Responsible Persistent</td>
</tr>
</tbody>
</table>

Table 19. The first factor loading profiles for combined disciplines at NCAT and at ISU

<table>
<thead>
<tr>
<th>Institutions</th>
<th>ISU</th>
<th>NCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disciplines (combined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Technology/ Engineering</td>
<td>Motivation Persistent Responsible Kinesthetic Tactile Authority figure Kinesthetic Tactile</td>
<td>Motivation Persistent Kinesthetic Motivation Responsible Persistent</td>
</tr>
</tbody>
</table>
The top five learning styles in Factor One combined accounted for 49.6 percent of the total variance in the factor loading profile. The first learning style (motivation) in Factor One accounted for 13.9 percent of the total variance. Table 20 provides the factor analysis results and Table 21 provides the names of the factors that explain the factor structure.

Eight factors were identified with eigenvalues greater than 1.00. Together, they explained 67.4 percent of the total variance in the factor structure for all (regardless of ethnicity). Three learning styles were removed in the factor structure because of confused loading. The top three learning styles combined in Factor One accounted for 32.5 percent of the total variance in the factor profile. The first learning style (afternoon) in Factor One accounted for 11.3 percent of the total variance.

Table 22 provides the factor analysis results and Table 23 provides the names of the factors that explain the factor structure. Table 24 provides an overview comparison of the factor loading profiles for the additional data of Industrial Technology and Engineering students.

To ascertain whether there was a difference between the factor structures Industrial Technology and Engineering, discriminant analysis was conducted. A Box's M Test revealed the two factor structures were not statistically significantly different. F (210.807342) = 207.142, p = .699.
Table 20. Factor loading profiles for combined samples (NCAT & ISU) of African American and European American students in Industrial Technology

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Motivation</td>
<td>.806</td>
</tr>
<tr>
<td>Persistent</td>
<td>.751</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>.710</td>
</tr>
<tr>
<td>Responsibility</td>
<td>.612</td>
</tr>
<tr>
<td>Tactile</td>
<td>.532</td>
</tr>
<tr>
<td>Afternoon</td>
<td></td>
</tr>
<tr>
<td>Late Morning</td>
<td></td>
</tr>
<tr>
<td>Time of Day</td>
<td></td>
</tr>
<tr>
<td>(Evening/Morning)</td>
<td></td>
</tr>
<tr>
<td>Alone/Peers</td>
<td></td>
</tr>
<tr>
<td>Several Ways</td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
</tr>
<tr>
<td>Intake</td>
<td></td>
</tr>
<tr>
<td>Structure</td>
<td></td>
</tr>
<tr>
<td>Authority Figure</td>
<td></td>
</tr>
<tr>
<td>Auditory</td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
</tr>
</tbody>
</table>
Table 21. Names for factors of Industrial Technology students at NCAT and ISU combined

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hands-on/Independent Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Social Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Environmental/Time Out Oriented Learner</td>
</tr>
<tr>
<td>5</td>
<td>Detailed/Oriented Learner</td>
</tr>
<tr>
<td>6</td>
<td>Hear/Sight Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Climate Oriented Learner</td>
</tr>
<tr>
<td>8</td>
<td>Sight Oriented Learner</td>
</tr>
</tbody>
</table>
Table 22.  Factor loading profile for combined samples (NCAT & ISU) of African American and European American students in Engineering

<table>
<thead>
<tr>
<th>Learning styles</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afternoon</td>
<td>-0.943</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Morning</td>
<td>0.847</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time of Day (Evening/Morning)</td>
<td>0.762</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Responsibility</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Motivation</td>
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<td>Tactile</td>
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<td>0.655</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Kinesthetic</td>
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<td></td>
<td>0.605</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alone/Peers</td>
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<td></td>
<td>0.870</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Several Ways</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.870</td>
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<td></td>
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<td></td>
<td></td>
<td>0.628</td>
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</tr>
<tr>
<td>Visual</td>
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<td></td>
<td>0.909</td>
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<td>Mobility</td>
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<td></td>
<td>0.828</td>
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<tr>
<td>Temperature</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>0.849</td>
</tr>
</tbody>
</table>
Table 23. Names for factors of Engineering students at NCAT and ISU combined

<table>
<thead>
<tr>
<th>Factor</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Time Oriented Learner</td>
</tr>
<tr>
<td>2</td>
<td>Complex/Independent Oriented Learner</td>
</tr>
<tr>
<td>3</td>
<td>Hands-on/Detailed/Collaborator Oriented Learner</td>
</tr>
<tr>
<td>4</td>
<td>Social Oriented Learner</td>
</tr>
<tr>
<td>5</td>
<td>Formal Climate/Illuminous Oriented Learner</td>
</tr>
<tr>
<td>6</td>
<td>Perceptual Oriented Learner</td>
</tr>
<tr>
<td>7</td>
<td>Movement Oriented</td>
</tr>
<tr>
<td>8</td>
<td>Climate Oriented Learner</td>
</tr>
</tbody>
</table>

Table 24. Overview of additional data for comparing Factor One for Industrial Technology and Engineering students (African American and European American combined)

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Industrial Technology</th>
<th>Engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td>Persistent</td>
<td>Afternoon</td>
</tr>
<tr>
<td>Persistent</td>
<td>Kinesthetic</td>
<td>Late morning</td>
</tr>
<tr>
<td>Kinesthetic</td>
<td>Responsibility</td>
<td>Time of day</td>
</tr>
<tr>
<td>Responsibility</td>
<td>Tactile</td>
<td></td>
</tr>
</tbody>
</table>

Summary

This chapter provided a description of the sample by gender and subdiscipline. A normality check of the factor scores was conducted to verify if an acceptably normal distribution existed as necessary to proceed with the analysis. A factor analysis was used to reduce 20 elements of the PEPS to a smaller number of variables to ascertain the preferred learning style preferences of the groups. Names were provided for the factors to provide an
understanding of each of the factor loading profiles. These names explained the underlying construct of the variables that loaded. Three hypotheses were tested using the discriminant analysis (Box's M Test) to determine whether there were statistically significant differences between the groups. Additional analyses were conducted to provide further insight into how African American and European American students compare within their respective disciplines.
CHAPTER 5. SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

This study investigated the learning style preferences of Industrial Technology and Engineering students at Iowa State University and at North Carolina A&T State University. This chapter recapitulates the need for the study, the methodology and statistical treatment, as well as presents conclusions and provides a discussion. In addition, major implications based of the results of the study along with recommendations for practice and further research are provided.

Problem and Purpose

Two characteristics highlight the problem addressed by this study: 1) the lack of current and useful information about the learning styles of students of color in technical disciplines in post-secondary institutions, and 2) a weakness in the extent to which technical faculty and teaching assistants are informed about learning styles and their implications.

The purpose of this study was to ascertain if learning style differences, as measured by the Productivity Environmental Preference Survey (PEPS), exist between African American students enrolled in Engineering and Industrial Technology at North Carolina A&T State University and European American students at Iowa State University.

Summary of the Sample

The original sample size for this study was 540. The sample size was reduced to 536 because of missing and outlier data.
In the Industrial Education and Technology Department at ISU, the sample size consisted of 96 percent male and 4 percent female of which only 2 percent were African American with the 98 percent balance being European American. The sample of students from Industrial Technology at ISU totaled 135. The breakdown of students by subdiscipline was 82 percent Manufacturing, 15 percent Occupational Safety, and 3 percent Training and Development.

The sample from ISU’s College of Engineering consisted of 60 percent males and 40 percent females. The ethnic composition of this sample was 2 percent African American and 98 percent European American. The sample collected from ISU’s College of Engineering was 134 students. The student breakdown by discipline was 23 percent Mechanical Engineering, 20 percent Civil Engineering, 13 percent Chemical Engineering, 10 percent Industrial Engineering, 9 percent Computer Engineering, 8 percent Electrical Engineering, 7 percent Agriculture Engineering, 4 percent Aerospace Engineering, 2 percent Engineering Science, 2 percent Metallurgy Engineering, 2 percent Construction Engineering, and .8 percent Ceramics Engineering.

NCAT’s School of Technology consisted of 70 percent males and 30 percent females along with an ethnic composition of 100 percent African American. There were no European American students or other ethnic groups at NCAT who participated in the study. The sample size collected from the School of Technology at NCAT was 131 students. The student breakdown by subdiscipline was 49 percent Electronics Communication, 34 percent Manufacturing, 12 percent Graphics Communication, 4 percent Occupational Safety, and .8 percent Construction Management.
The sample from the College of Engineering at NCAT consisted of 60 percent males and 40 percent females with an ethnicity of 96 percent African American and 4 percent European American. The sample size for students from the College of Engineering at NCAT totaled 136. The student composition identified by subdiscipline was 40 percent Electrical Engineering, 13 percent Computer Engineering, 12 percent Mechanical Engineering, 11 percent Architectural Engineering, 9 percent Chemical Engineering, 3 percent Civil Engineering, and .8 percent Manufacturing Engineering.

Summary of the Data Analysis

Five steps were used to examine the differences of preferred learning styles among African American and European American students by ethnicity and by discipline at North Carolina A&T State University and Iowa State University.

1. A factor analysis was used to reduce the number of variables.
2. As a result of confused loading, some variables were systematically excluded from the factor structure.
3. The factors were given names/labels. In each of the first factors, the first variable was considered the "most influential."
4. Three null hypotheses were tested using a discriminant analysis and a Box’s M Test.
5. Additional analyses were generated.
Summary Findings and Conclusions

This section provides the summary of the factor structures that were produced, the findings as a result of the analyses, followed by the conclusions. Descriptions for the learning styles produced by the findings are also included.

Research Question One

The first research question asked if a difference existed between the factor loading profiles of the learning styles of African American students at NCAT and factor loading profiles of the learning styles of European American students at ISU.

The factor structure for African Americans identified eight factors. The explained variance was 66.6 percent. The first learning style in Factor One accounted for 13.4 percent of the variance. The combined top three learning styles accounted for 33.5 percent of the total variance for the African American students' factor loading profile. Factor One was named "Physically Involved/Independent Oriented Learners" to describe the three learning styles for African Americans. The three preferred learning styles revealed were 1) motivation, 2) persistent, and 3) kinesthetic.

The factor structure for European Americans identified seven factors. The explained variance was 64.5 percent. The first learning style in Factor One accounted for 12 percent of the total variance. Factor One's combined top three learning styles together accounted for 34.3 percent of the total variance for the European American students' factor loading profile. Factor One was named "Complex/Independent Oriented Learners" to describe the three learning styles for European Americans. The three preferred learning styles were 1) responsible, 2) motivation, and 3) persistent.
Table 25 illustrates a comparison of Factor One constructs for African Americans and European Americans. The descriptions of the learning styles for African American and European American students are quoted from the 1996 PEPS Manual (Price, 1996 pp. 7-11).

The null hypothesis for Research Question One was rejected and the alternative hypothesis was accepted. Box’s M Test in the discriminant analysis showed a $p$-value of .025, which is smaller than the a priori, alpha level of .05. Therefore, there is a difference between the factor loading profiles of African American and European American students.

Table 25. Comparison of Factor One loadings for African American and European American students

<table>
<thead>
<tr>
<th></th>
<th>African Americans “Physically Involved/Independent Oriented Learners”</th>
<th>European Americans “Complex/Independent Oriented Learners”</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOTIVATION</td>
<td>Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8)</td>
<td>Students preferred faculty to design short-term assignments that can be successfully completed. The assignments were increased by length and difficulty to challenge their abilities or outside their limits. (p. 8)</td>
</tr>
<tr>
<td>PERSISTENT</td>
<td>Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8)</td>
<td>Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8)</td>
</tr>
<tr>
<td>KINESTHETIC</td>
<td>Students preferred to experience real-life activities for preparing and carrying out objectives. Seeing projects conducted and becoming physically involved when desired. (p. 10)</td>
<td>Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8)</td>
</tr>
</tbody>
</table>
The factor named “Physically Involved/Independent Oriented Learner” was used to describe the overall preferred learning style for African Americans. Based on the results of this study, African Americans had a need to do hands-on, real-life activities and use self-designed objectives and procedures to do assignments that include potential for more challenging work. The literature review reinforces the view by cultural theorists that learning styles are influenced differently by ethnicity. Researchers who study African American learning styles believe that African Americans learn differently than European Americans (Hale-Benson, 1986; Melear, 1995). This belief may also suggest different learning styles may result from socialization practices and values, which stem from a particular cultural value system (Ramirez & Casteneda, 1974). The need for these students to be physically active supports the claim that African Americans are more inclined to be movement oriented as suggested by Hale-Benson (1986) and Boykin (1983).

Research Question Two

The second research question inquired if a difference exists between the factor loading profiles of African American students enrolled in Industrial Technology when compared with African American students enrolled in Engineering at North Carolina A&T State University.

The factor structure for African Americans in Industrial Technology at NCAT had eight factors. The total variance explained was 68.4 percent. Factor One’s combined three learning styles accounted for 33.7 percent of the total variance. The first learning style in Factor One accounted for 13.9 percent of the total variance. Factor One was named “Physically Involved/Independent Oriented Learners” to describe the three learning styles for
African Americans in Industrial Technology. The three learning styles were 1) motivation, 2) persistent, and 3) kinesthetic.

In Engineering at NCAT, there were eight factors identified explaining 68.5 percent. The first learning style in Factor One accounted for 12.2 percent of the total variance. Factor One’s combined top three learning styles accounted for 32.9 percent of the total variance for Engineering students’ preferred learning style profile. Factor One was named “Complex/Independent Oriented Learners” to describe the three learning styles for African American students in Engineering. The three preferred learning styles were 1) motivation, 2) responsible, and 3) persistent. Table 26 displays the results of Factor One comparing African American students in Industrial Technology with students in Engineering at NCAT. The descriptions of the learning styles were quoted from the 1996 PEPS Manual (Price, 1996, pp. 7-11). The null hypothesis for Research Question Two was not rejected (fail to reject) and the null hypothesis was accepted. Box’s M Test in the discriminant analysis showed a p-value of .385 which is larger than the a priori alpha level of .05. Therefore, there was no difference between factor loading profiles of Industrial Technology and Engineering students at North Carolina A&T State University.

Research Question Three

The third research question asked if a difference exists between the factor loading profiles of European American students enrolled in Industrial Technology when compared with European American students enrolled in Engineering at Iowa State University.

The factor structure for European Americans in Industrial Technology at ISU had eight factors explaining 71 percent of the total variance. The first learning style in Factor One
accounted for 13.8 percent of the total variance. Factor One’s top five variables combined accounted for 51.9 percent of the total variance. Factor One was named “Hands-On/Independent Oriented Learners” to describe the three learning styles for European Americans in Industrial Technology. The five preferred learning styles were 1) motivation, 2) persistent, 3) responsible, 4) kinesthetic, and 5) tactile.

The factor structure for European Americans in Engineer at ISU had seven factors explaining 66.8 percent of the total variance. The first learning style in Factor One accounted for 12.1 percent of the total variance. Factor One’s top three variables combined accounted

Table 26. Comparison of Factor One loadings for Industrial Technology and Engineering students at NCAT

<table>
<thead>
<tr>
<th></th>
<th>Industrial Technology</th>
<th></th>
<th>Engineering</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Physically Involved/Independent Oriented Learners”</td>
<td></td>
<td>“Complex/Independent Oriented Learners”</td>
<td></td>
</tr>
<tr>
<td><strong>MOTIVATION</strong></td>
<td>Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8)</td>
<td>Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PERSISTENT</strong></td>
<td>Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8)</td>
<td>Students preferred faculty to design short-term assignments that can be successfully completed. The assignments were increased by length and difficulty to challenge their abilities or outside their limits. (p. 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>KINESTHETIC</strong></td>
<td>Students preferred to experience real-life activities for preparing and carrying out objectives. Seeing projects conducted and becoming physically involved when desired. (p. 10)</td>
<td>Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
for 35 percent of the total variance. Factor One was named "Hands-On/Collaborative Oriented Learners" to describe the three learning styles for European Americans in Engineering. The three preferred learning styles were 1) authority figure, 2) kinesthetic, 3) and tactile.

Table 27 illustrates the results of Factor One for European American students in Industrial Technology compared to students in Engineering at ISU. The descriptions of the learning styles were quoted from the 1996 PEPS Manual (Price, 1996, pp. 7-11). The null hypothesis for Research Question Three was not rejected (fail to reject) and the null hypothesis was accepted. Box's M Test in the discriminant analysis showed a p-value of .263, which is larger than the a priori alpha level of .05. Therefore, there was no difference between preferred learning style profiles for Industrial Technology and Engineering students at Iowa State University.

Additional analyses were conducted to explore out of the ordinary results that emerged from the initial analysis. The factor structure for African American and European students who enrolled in Industrial Technology had eight factors explaining 67.2 percent of the total variance. The first learning style in Factor One accounted for 13.9 percent of the total variance. Factor One's top five learning styles combined accounted for 49.6 percent of the total variance for industrial technology students' factor loading profile. Factor One was named "Hands-on/Independent Oriented Learners" to describe the five learning styles for both ethnic groups in Industrial Technology. The five preferred learning styles were 1) motivation, 2) persistent, 3) responsible, 4) kinesthetic, and 5) tactile.

The factor structure for African American and European students who enrolled in Engineering had eight factors explaining 67.4 percent of the total variance. The first learning
Table 27. Comparison of Factor One loadings for Industrial Technology and Engineering students at ISU

<table>
<thead>
<tr>
<th></th>
<th>Industrial Technology “Hands-on/Independent Oriented Learners”</th>
<th>Engineering “Hands-on/Collaborative Oriented Learners”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MOTIVATION</strong></td>
<td>Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8)</td>
<td><strong>AUTHORITY FIGURE</strong> Engineering students preferred to be near faculty and scheduled meetings or visit faculty to check work often. Engineering students provided frequent feedback through their perceptual strengths. (p. 9)</td>
</tr>
<tr>
<td><strong>PERSISTENT</strong></td>
<td>Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8)</td>
<td><strong>KINESTHETIC</strong> Students preferred to experience real-life activities for preparing and carrying out objectives. Seeing projects conducted and becoming physically involved when desired. (p. 10)</td>
</tr>
<tr>
<td><strong>RESPONSIBLE</strong></td>
<td>Students preferred faculty to design short-term assignments that can be successfully completed. The assignments were increased by length and difficulty to challenge their abilities or outside their limits. (p. 8)</td>
<td><strong>TACTILE</strong> Students preferred to use three-dimensional materials that can be manipulated. Resources should be touchable, movable, and readable to students. Engineering students used objects or models to plan, demonstrate and report. (p. 10)</td>
</tr>
<tr>
<td><strong>KINESTHETIC</strong></td>
<td>Students preferred to experience real-life activities for preparing and carrying out objectives. Seeing projects conducted and becoming physically involved when desired. (p. 10)</td>
<td></td>
</tr>
<tr>
<td><strong>TACTILE</strong></td>
<td>Students preferred to use three-dimensional materials that can be manipulated. Resources should be touchable, movable, and readable to students. Engineering students used objects or models to plan, demonstrate and report. (p. 10)</td>
<td></td>
</tr>
</tbody>
</table>
style in Factor One accounted for 11.3 percent of the total variance. Factor One’s top three learning styles combined accounted for 32.5 percent of the total variance. Factor One was named “Time-Oriented Learners” to describe the three learning styles for both ethnic groups in Engineering. The three preferred learning styles were 1) Afternoon, 2) Late Morning, and 3) Time of Day.

Table 28 illuminates details of Factor One for African Americans and European American students combined in Industrial Technology compared to African Americans and European American combined in Engineering. The descriptions of the learning styles were quoted from the 1996 PEPS Manual (Price, 1996, pp. 7-11).

**Discussion**

This study evolved to employ an analytical methodology different than that which was originally proposed. An analysis of variance, as originally planned, was not used in this methodology because the factor structures for Industrial Technology and Engineering at NCAT and Industrial Technology and Engineering at ISU were different. After extensive consultation with statisticians, the discriminant analysis with the Box’s M Test emerged as the appropriate statistical method to test the hypotheses. The purpose of the Box’s M Test within the discriminant analysis was to determine whether a significant difference existed between the groups being compared.

According to Stevens (1986), the discriminant analysis has two excellent features/benefits: 1) the descriptions are carefully calculated and, 2) there is clarity of interpretation. He further explains,
Table 28. Comparison of Factor One loadings for Industrial Technology and Engineering students

<table>
<thead>
<tr>
<th></th>
<th><strong>Industrial Technology</strong></th>
<th><strong>Engineering</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;Hands-on/Independent Oriented Learners&quot;</td>
<td>&quot;Time Oriented Learners&quot;</td>
</tr>
</tbody>
</table>
| MOTIVATION           | Students preferred faculty to use self-designed objectives and procedures without early intervention of an instructor or supervisor to evaluate effort. African American students wanted to pace themselves and looked for prompt achievement. (p. 8) | AFTERNOON
These students do not like to schedule difficult tasks in the afternoon. (p. 11) |
| PERSISTENT           | Students preferred long-term assignments with supervision and help, if needed. Students enjoyed praises from faculty when assignments were completed. (p. 8) | LATE MORNING
These students do not like to schedule difficult tasks in the late morning. (p. 11) |
| RESPONSIBLE          | Students preferred faculty to design short-term assignments that can be successfully completed. The assignments were increased by length and difficulty to challenge their abilities or outside their limits. (p. 8) | TIME OF DAY
These students prefer to schedule difficult tasks in the morning. (p. 11) |
| KINESTHETIC          | Students preferred to experience real-life activities for preparing and carrying out objectives. Seeing projects conducted and becoming physically involved when desired. (p. 10) | |
| TACTILE              | Students preferred to use three-dimensional materials that can be manipulated. Resources should be touchable, movable, and readable to students. Engineering students used objects or models to plan, demonstrate and report. (p. 10) | |
[Discriminant analysis] can be quite parsimonious in that in comparing 5 groups on say 10 variables, we may find that the groups differ mainly on only two major dimensions, i.e., the discriminant functions. It has clarity of interpretation in the sense that separation of the two groups along one function is unrelated to separating along a different function. This is [acceptable], providing we can meaningfully name the discriminant functions and that there is adequate sample size so that the results are generalizable. (p. 233)

When using the discriminant analysis there are limitations to consider. There is the potential of misclassifying cases if the groups are not distinct. In other words, the decision rule may be difficult to use when attempting to classify cases. This type of analysis can only use large sample sizes to see how meaningful the differences are between two groups. This analysis does not produce casual explanations and is dependent upon all relevant factors.

This study used a factor analysis to analyze the variables. Both benefits and limitations are derived from using the factor analysis. The benefit of the factor analysis enabled the researcher to find underlying patterns that might be revealed by looking at data relationships. The limitations of using a factor analysis include 1) patterns that the factor analysis provide require a high degree of subjectivity to interpret meaningfully; 2) factors might measure the construct, so the results are generally more abstract; 3) a large sample size is needed to conduct the analysis; and 4) there may not be a sufficient amount of scales or items needed to represent each underlying dimension.

The variables in the Factor One in Hypothesis 1 were closely examined. African Americans were known as “Physically-Involved/Independent-Oriented Learners” and “Complex/Independent-Oriented Learners” for European Americans. It is often perceived that many African Americans have to work twice as hard in order to maintain a level of social status, prosperity, and acceptance. The European Americans’ learning styles described as “Complex/Independent Oriented Learner” are taught to be competitive at a very young
age—these individuals are groomed for success early. According to Holmes, Ebbers, Robinson, & Mugenda (2000), the American education system, driven by the philosophy of realism, supports the learning styles of European Americans which have been described as competitive and self-centered.

The findings from Hypotheses 2 and 3 indicate that there were no differences between the ethnic groups within their disciplines at their respective institutions. There are two probable explanations. First, faculties in Industrial Technology and Engineering at both institutions are utilizing teaching styles that already complement the students' learning styles. This speculation cannot be confirmed without further research. Second, students in their respective disciplines and institutions may be demonstrating a successful adaptation to the culture and teaching styles of the discipline. Kolb (1981) concluded that undergraduate education shapes students' learning styles. It is also suggested as a result of the reoccurring learning style preferences of "motivation and persistent" which can be observed in each group's profile, that these students, regardless of their ethnic background are acclimating to a learning and teaching environment that is conducive to how they learn. In short, these students appear to be self-selecting a program of study that suits their learning style.

The findings from Hypothesis 1, 2, and 3 were examined and provided speculation that ethnicity may be a stronger or more influential variable than academic disciplines regardless of the institution. Cultural theorists maintain that culture can influence an individual's learning style. Culture, which was not examined in this study, may contribute to the differences between the groups. In reference to people of color, Ramirez and Castaneda (1974) explain that the teaching styles and culture of the home can shape the learning style of an individual. In essence, students of African American and European American background
are acculturated in their homes, then the students use their “essentials” (e.g., survival skills, social skills, people skills) to function in mainstream society. Every individual who enters into a post-secondary institution brings unique and complex learning patterns and experiences to the system of higher education. This supports the need for additional research that investigates the learning styles among people of color.

The investigator needs to reiterate the difficulty in generalizing from this study because it employed a convenience sample. The purpose of this study was not to “compartmentalize” students into a particular learning style. Guild (1994) noted that “generalizations about a group of people often lead to naive inferences about individual members of that group” (p. 17). Therefore, these results cannot be generalized to any other group than those who participated in the study. Their styles of learning may dictate how they were exposed to pedagogies through their educational experience and in the home.

**Recommendations for Practice**

This study produced results that faculty and teaching assistants will find valuable in the course of their teaching. Results from this study will also benefit managers and supervisors in the field of industrial practice with respect to improving and/or increasing worker productivity. The recommendations for practice are as follows:

1. Provide staff development to assist faculty in increasing their knowledge base about diverse learning patterns.

2. Establish orientation or workshops for incoming teaching assistants to provide training and awareness of how to teach diverse populations.
3. In order to promote an optimal work environment, managers and supervisors in an industrial setting, using information about diverse learning patterns, can move toward improving worker production and employee satisfaction. The reason for this practice is because learning styles of students may very well transfer from academia to the workplace.

**Recommendations for Future Research**

The data in the study should be viewed as a catalyst to conduct further research into learning styles of students of color in technical programs at institutions of higher education. Recommendations for future study include:

1. There is a need to replicate this study with a larger and more representative sample.

2. Further study is needed of the preferred learning styles of African Americans in other National Association of Industrial Technology (NAIT)-accredited Industrial Technology and American Board of Engineering and Technology (ABET)-accredited Engineering programs across the United States.

3. Further investigation is needed of the preferred learning styles of other ethnicities, i.e., Asian, Hispanic, Native American.

4. There is a need to examine the preferred learning styles of males and females in Industrial Technology and Engineering.

5. There is a need to examine the preferred learning styles and teaching styles of faculty in Industrial Technology and Engineering programs at Iowa State University and North Carolina A&T State University.
6. Further study is needed to determine if there are any differences in preferred learning styles of Industrial Technology and Engineering students based on socioeconomic status.

7. There may be a need to investigate the preferred learning styles of students in other disciplines.

8. There may be a need to investigate Kolb's (1981) conclusion on shaping learning styles through disciplines using other learning style instruments. Further study is needed to examine the differences between the learning styles of students who attended undergraduate school and are presently enrolled in graduate school at the same institution when compared with students who attended undergraduate school and presently enrolled at a different graduate school.

9. Based on the significant findings in Hypothesis 1, a study should be conducted that examines how and why culture influences particular learning styles among diverse groups.

10. Further investigation is needed to determine the preferred learning styles of Industrial Technology students at technical institutions outside the United States.

11. There is a need for further improvement of validity for the PEPS or other learning style instruments, and further investigation is needed to determine predictive and construct validity using students from Industrial Technology or Engineering.
APPENDIX A. HUMAN SUBJECTS APPROVAL FOR ISU AND NCAT
Iowa State University
Human Subjects Review Form
(Please type and use the attached instructions for completing this form)

1. Title of Project: A Comparison study of learning styles of Industrial Technology and Engineering Students at Iowa State University with Industrial Technology and Engineering students at North Carolina A&T University

2. I agree to provide the proper surveillance of this project to insure that the rights and welfare of the human subjects are protected. I will report any adverse reactions to the committee. Additions to or changes in research procedures after the project has been approved will be submitted to the committee for review. I agree that all key personnel involved in conducting human subjects research will receive training in the protection of human subjects. I agree to request renewal of approval for any project continuing more than one year.

Dominick E. Fazarro
Typed name of principal investigator
1-31-2001
Date
Signature of principal investigator

Industrial Education and Technology
Department
215 l ED II
Campus Address
515-294-8332 fazarro@iastate.edu
Phone number and email

2a. Principal investigator

3a. Co-Principal investigator(s) (check all that apply)

3b. Typed name of major professor or supervisor
(if not a co-principal investigator)

Larry Bradshaw
1-31-2001
Signature of major professor or supervising faculty member

4. Typed names of other key personnel who will directly interact with human subjects:
Angela Whitehead, Anthony Stevens, Micheal Williams

5. Project (check all that apply)

6. Number of subjects (complete all that apply)

# adults, non-students 304 # ISU students 304 # other (explain)
# minors under 14 304 # minors 14-17

7. Status of project submission through Office of Sponsored Programs Administration (check one)

7a. Funding Source:

8. Brief description of proposed research involving human subjects: (See instructions, item 8. Use an additional page)
PI Name: Dominick E. Fazano
Title of Project: A Comparison study of learning styles of Industrial Technology and Engineering Students at Iowa State University with Industrial Technology and Engineering students at North Carolina A&T University

Checklist for Attachments

The following are attached (please check):

13. ☑ Letter or written statement to subjects indicating clearly:
   a) the purpose of the research
   b) the use of any identifier codes (names, #'s), how they will be used, and when they will be removed (see item 18)
   c) an estimate of time needed for participation in the research
   d) if applicable, the location of the research activity
   e) how you will ensure confidentiality
   f) in a longitudinal study, when and how you will contact subjects later
   g) that participation is voluntary; nonparticipation will not affect evaluations of the subject

14. ☑ A copy of the consent form (if applicable)

15. ☑ Letter of approval for research from cooperating organizations or institutions (if applicable)

16. ☑ Data-gathering instruments

17. Anticipated dates for contact with subjects:
   First contact
   2-26-2001
   Month/Day/Year
   Last contact
   3-02-2001
   Month/Day/Year

18. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:
   Month/Day/Year

19. Signature of Departmental Executive Officer
   Date
   Department or Administrative Unit
   Patricia M. Keith
   2-12-01
   Industrial Education Technology

20. Initial action by the Institutional Review Board (IRB):
   Project approved _______ Date
   □ Pending Further Review _______ Date
   □ Project not approved _______ Date
   □ No action required _______ Date

21. Follow-up action by the IRB:
   Project approved _______ Date
   Project not approved _______ Date
   Project not resubmitted _______ Date

Name of IRB Chairperson
   Patricia M. Keith
   2-12-01
   Signature of IRB Chairperson
TO: Dominick E. Fazaro
FROM: Eric Allen
DATE: 3-6-01
RE: Approval for research

Mr. Fazaro:

I have gone over every part of this project in which you wish to conduct on our campus. All contacts have been made and approvals to coincide with them. I have enclosed a copy of the approval documents for your records. The study has been approved by our IRB and you are cleared to conduct your research. I look forward to meeting you and hope that your research is successful.

Sincerely

[Signature]

Eric Allen - Compliance Manager (IRB)
March 5, 2001

Dominick E. Fazano
C/O Dr. Eric A. Cheek, Assistant Dean
College of Engineering
Campus

Refer to: IRB #01-0000-H15

Dear Mr. Fazano:

As required by University policy I have given your anonymous survey protocol entitled "A comparison study of learning styles of engineering and technology students at Iowa and NC A&T State Universities" (IRB #01-0000-H15) an audit review. I agree that your proposal is exempt from 45 CFR 46 as no minors will be surveyed. As per A&T's Federal Wide Assurance (FWA00000013) with the Office for Protections from Research Risks (OPRR) of the Department of Health and Human Services, all exempt research must be conducted in accordance with the Belmont Report (DHEW Publication No. (OS) 78-0012) which requires voluntary, informed consent from research subjects. You will document obtaining informed consent from interview subjects by the use of the submitted consent form. You should be aware that any changes in your protocol must be submitted to the IRB before they are implemented. Likewise, any problems or complaints involving human subjects must be promptly reported to the IRB.

Thank you for your cooperation on this matter and best wishes on your project.

Sincerely,

David W. Aldridge, IRB Chairperson

cc: Ms. Valerie Howard, DOR
    Dr. Eric A. Cheek, Assistant Dean, College of Engineering
    Dr. Joseph Monroe, Dean, College of Engineering
    Dr. Elazor Barnette, Dean, School of Technology

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Phone: (336) 334-7907 • Fax: (336) 334-7105 • E-Mail:biology@ncat.edu
APPENDIX B. LETTERS TO REQUEST PERMISSION
February 13, 2001

Dr. Dan Householder  
Chairperson, Industrial Education  
& Technology Department  
I ED II Building  
Iowa State University  
Ames, IA. 50010

Dr. Householder:

I would like to request permission to conduct a study pertaining to learning styles of undergraduate students in the College of Engineering. The purpose of this research is to determine what are the preferred learning styles of Engineering students. In addition, the learning styles of the Industrial Technology students of Iowa State University will be compared with the Engineering students along with the Industrial Technology and Engineering students at North Carolina A&T University. In essence, I want to ascertain if there is a difference in preferred learning styles between Industrial Technology and Engineering students. This study is important to provide data of various learning styles in finding new ways to improve teaching methods for faculty, especially at predominately white institutions.

The instrument selected for the study is called the Productivity Environmental Preference Survey. This survey determines the preferred learning styles preferences of students. There will be no names of the subjects mentioned on the inventory. There will be codes provided only for ethnicity, school classification, program of choice, and gender. There will be no videotapes and recordings used for this study, therefore confidentiality is ensured.

The test is comprised of 100 statements that are geared towards everyday life activities. The inventory should take no longer than 30 minutes. Five minutes will be used to explain what information (ethnicity, school classification, program of choice, and sex) is required for demographic purposes.

I would like to sample 152 undergraduate students in the department according to their school classification. If possible the inventories could be administered to students on these days in the late morning or afternoon.

38-freshmen (Monday)  38-juniors (Wednesday)  
38-sophomores (Tuesday)  38-Seniors (Thursday)

This study is based on modified consent to participate. Nonparticipation will not affect the evaluations of the subjects. A pizza party will be provided for those who wish to participate in the study. I would like to contact you two weeks in advance to set up dates and times to conduct the study. If you have any questions or suggestions, please e-mail (fazarro@iastate.edu) or call 294-8332. Thank you.

Sincerely,

Dominick E. Fazarro  
Principal Investigator  
Department of Industrial Education and Technology  
215 I ED II  
Ames, IA. 50011
Dr. Loren Zachary:

I would like to request permission to conduct a study pertaining to learning styles of undergraduate students in the College of Engineering. The purpose of this research is to determine what are the preferred learning styles of Engineering students. In addition, the learning styles of the Industrial Technology students of Iowa State University will be compared with the Engineering students along with the Industrial Technology and Engineering students at North Carolina A&T University. In essence, I want to ascertain if there is a difference in preferred learning styles between Industrial Technology and Engineering students. This study is important to provide data of various learning styles in finding new ways to improve teaching methods for faculty, especially at predominately white intuitions.

The instrument selected for the study is called the Productivity Environmental Preference Survey. This survey determines the preferred learning styles preferences of students. There will be no names of the subjects mentioned on the inventory. There will be codes provided only for ethnicity, school classification, program of choice, and gender. There will be no videotapes and recordings used for this study, therefore confidentiality is ensured.

The test is comprised of 100 statements that are geared towards everyday life activities. The inventory should take no longer than 30 minutes. Five minutes will be used to explain what information (ethnicity, school classification, program of choice, and sex) is required for demographic purposes.

I would like to sample 152 undergraduate students in the College of Engineering according to their school classification. If possible the inventories could be administered to students on these days in the late morning or afternoon.

38-freshmen (Monday) 38-juniors (Wednesday)
38-sophomores (Tuesday) 38-Seniors (Thursday)

This study is based on modified consent to participate. Nonparticipation will not affect the evaluations of the subjects. A pizza party will be provided for those who wish to participate in the study. I would like to contact you in one week in advance to set up dates and times for four days in March after Spring Break to conduct the study. If you have any questions or suggestions, please e-mail (fazarro@iastate.edu) or call 294-8332. Thank you.

Sincerely,

Dominick E. Fazarro
Principal Investigator
Department of Industrial Education and Technology
215 1 Ed II
Ames, IA. 50011

Cc: Karen Zunkel
March 5, 2001

Dr. Elazer Barnette
Dean of School of Technology
Smith Hall
North Carolina A&T University
1601 E. Market St.
Greensboro, NC 27411

Dr. Barnette:

I would like to request permission to conduct a study pertaining to learning styles of undergraduate students in the College of Engineering. The purpose of this research is to determine what are the preferred learning styles of Engineering students. In addition, the learning styles of the Industrial Technology students of North Carolina A&T University will be compared with the Engineering students at North Carolina A&T University and Industrial Technology and Engineering students at Iowa State University. In essence, I want to ascertain if there is a difference in preferred learning styles between Industrial Technology and Engineering students. This study is important to provide data of various learning styles in finding new ways to improve teaching methods for faculty, especially at predominately white institutions.

The instrument selected for the study is called the Productivity Environmental Preference Survey. This survey determines the preferred learning styles preferences of students. There will be no names of the subjects mentioned on the inventory. There will be codes provided only for ethnicity, school classification, program of choice, and gender. There will be no videotapes and recordings used for this study, therefore confidentiality is ensured.

The test is comprised of 100 statements that are geared towards everyday life activities. The inventory should take no longer than 30 minutes. Five minutes will be used to explain what information (ethnicity, school classification, program of choice, and sex) is required for demographic purposes.

I would like to sample 152 undergraduate students in the School of Technology according to their school classification. If possible the inventories could be administered to students on these days in the late mornings.

38-freshmen (Monday) 38-juniors (Wednesday)
38-sophomores (Tuesday) 38-Seniors (Thursday)

This study is based on modified consent to participate. Nonparticipation will not affect the evaluations of the subjects. I would like to conduct this study March 12th-16th. If you have any questions or suggestions, please e-mail (fazarro@iastate.edu) or call (515) 294-8332. Thank you for your support.

Sincerely,

Dominick E. Fazarro
Principal Investigator
Department of Industrial Education and Technology
215 I Ed II
Ames, IA 50011

Cc: Dr. Marcus Tillery
March 5, 2001

Dr. Joseph Monroe  
Dean, College of Engineering  
651 McNair Hall  
North Carolina A&T University  
Greensboro, NC 27411

Dr. Monroe:

I would like to request permission to conduct a study pertaining to learning styles of undergraduate students in the College of Engineering. The purpose of this research is to determine what are the preferred learning styles of Engineering students. In addition, the learning styles of the Industrial Technology students of North Carolina A&T University will be compared with the Engineering students at North Carolina A&T University and Industrial Technology and Engineering students at Iowa State University. In essence, I want to ascertain if there is a difference in preferred learning styles between Industrial Technology and Engineering students. This study is important to provide data of various learning styles in finding new ways to improve teaching methods for faculty, especially at predominately white intuitions.

The instrument selected for the study is called the Productivity Environmental Preference Survey. This survey determines the preferred learning styles preferences of students. There will be no names of the subjects mentioned on the inventory. There will be codes provided only for ethnicity, school classification, program of choice, and gender. There will be no videotapes and recordings used for this study, therefore confidentiality is ensured.

The test is comprised of 100 statements that are geared towards everyday life activities. The inventory should take no longer than 30 minutes. Five minutes will be used to explain what information (ethnicity, school classification, program of choice, and sex) is required for demographic purposes.

I would like to sample 152 undergraduate students in the College of Engineering according to their school classification. If possible the inventories could be administered to students on these days in the late mornings.

38-freshmen (Monday)    38-juniors (Wednesday)  
38-sophomores (Tuesday)  38-Seniors (Thursday)

This study is based on modified consent to participate. Nonparticipation will not affect the evaluations of the subjects. I would like to conduct this study March 12th-16th. If you have any questions or suggestions, please e-mail (fazarro@iastate.edu) or call (515) 294-8332. Thank you for your support.

Sincerely,

Dominick E. Fazarro  
Principal Investigator  
Department of Industrial Education and Technology  
215 IED II  
Ames, IA. 50011
March 5, 2001

Dr. Eric Cheek
Associate Dean, College of Engineering
651 McNair Hall
North Carolina A&T University
Greensboro, NC 27411

Dr. Cheek:

I would like to request permission to conduct a study pertaining to learning styles of undergraduate students in the College of Engineering. The purpose of this research is to determine what are the preferred learning styles of Engineering students. In addition, the learning styles of the Industrial Technology students of North Carolina A&T University will be compared with the Engineering students at North Carolina A&T University and Industrial Technology and Engineering students at Iowa State University. In essence, I want to ascertain if there is a difference in preferred learning styles between Industrial Technology and Engineering students. This study is important to provide data of various learning styles/environments in finding new ways to improve teaching methods of students, especially at predominately white institutions.

The instrument selected for the study is called the Productivity Environmental Preference Survey. This survey determines the preferred learning styles preferences of students. There will be no names of the subjects mentioned on the inventory. There will be codes provided only for ethnicity, school classification, program of choice, and gender. There will be no videotapes and recordings used for this study, therefore confidentiality is ensured.

The test is comprised of 100 statements that are geared towards everyday life activities. The inventory should take no longer than 30 minutes. Five minutes will be used to explain what information (ethnicity, school classification, program of choice, and sex) is required for demographic purposes.

I would like to sample 152 undergraduate students in the College of Engineering according to their school classification. If possible the inventories could be administered to students on these days in the late mornings.

38-freshmen (Monday) 38-juniors (Wednesday)
38-sophomores (Tuesday) 38-Seniors (Thursday)

This study is based on modified consent to participate. Nonparticipation will not affect the evaluations of the subjects. I would like to contact you four weeks in advance to set up dates and times for four days in February to conduct the study. If you have any questions or suggestions, please e-mail (fazarro@iastate.edu) or call (515) 294-8332. This research benefits the continuing improvement in education into the twenty-first century.

Sincerely,

Dominick E. Fazarro
Principal Investigator
Department of Industrial Education and Technology
215 IED II
Ames, IA. 50011

Cc: Ms. Camilla Ross
APPENDIX C. LETTERS OF PERMISSION TO USE PEPS
June 6, 2001

Mr. Dominick E. Fazarro
Iowa State University
Industrial Education and Technology Dept.
215 I ED II
Ames, IA 50011

Dear Mr. Fazarro:

I want to take this means of giving you permission to use the PEPS for conducting research for your dissertation. I look forward to receiving a copy of your dissertation upon completion of your study. Good luck with your study.

Sincerely,

Gary E. Pace, Ph.D.
President

This letter of permission is a replacement for a misplaced one supplied prior to February 27th to conduct this study.
Dear Mr. Fazarro

Consider this permission to use Figure IF you send me one copy of your dissertation for our University Library! Also, we are writing a book on the LSs of various international groups and I may invite you to contribute a chapter, depending on your study! What did you find? Will you send me a cc?

Rita Dunn

Mail it to me at:

Center for the Study of Learning and Teaching Styles
St. John's University
8000 Utopia Parkway
Jamaica, NY 11439
APPENDIX D. PEPS LEARNING STYLE ELEMENTS
PEPS LEARNING STYLE ELEMENTS

These twenty learning styles are quoted from the PEPS Manual¹:

1. SOUND

For standard score of 60 or more, provide soft music, earphones, conversation areas, or an openwork environment. For standard score of 40 or less, establish silent areas; provide individual office alcoves with sound proofing; provide ear plugs to block sound, if necessary.

2. LIGHT

For standard score of 60 or more, place employee near window or under bright illumination; add table or desk lamps. For standard score of 40 or less, create work spaces under indirect or subdued light away from windows; use dividers or plants to block or diffuse light.

3. WARMTH

For standard score of 60 or more, provide adequate warmth, enclosures, screens, supplemental heaters and placement in warmer areas; allow sweaters; suggest use of warm colors and textured materials. For standard score of 40 or less, provide adequate air-conditioning, ventilation, and placement in cooler areas; suggest cool colors; permit short sleeved shirts, shorts, etc.

4. FORMAL/INFORMAL DESIGN

For standard score of 60 or more, create “formal” climate—rows of desks, straight chairs, walls having straight lines and simple designs, and direct lighting. For standard score of 40 or less, provide “informal” climate—soft chairs and couches, pillows, some color, lounge furniture, and indirect lighting.

5. MOTIVATED/UNMOTIVATED

For standard score of 60 or more, encourage use of self-designed objectives, procedures and evaluation before the instructor or supervisor assesses effort; permit self-pacing and rapid achievement.

For standard score of 40 or less, design short-term, simple, uncomplicated assignments that require frequent discussions with the instructor or supervisor, provide several easily

understood options based on the individual’s interests; experiment with short-range motivators and reinforcement; solicit self-developed goals and procedures; log results and progress; provide opportunities for success and achievement on cooperatively-designed objectives.

6. PERSISTENT

For standard score of 60 or more, design long-term assignments; provide supervision and assistance only when necessary; suggest when help may be obtained if necessary; praise at completion of assignment.

7. RESPONSIBLE (CONFORMING)

For standard score of 60 or more, begin by designing short-term assignments; as these are successfully completed, gradually increase their length and scope; challenge the individual at the level of his or her functional ability or slightly beyond.

8. STRUCTURE

For standard score of 60 or more, be precise about every aspect of the assignment; permit no options; use clearly stated objectives in a simple form; list and itemize as many things as possible, leave nothing for interpretation; clearly indicate time requirements and the resources that may be used; required tasks should be indicated as successful completion is evidenced, gradually lengthen the assignment and provide some choices from among approved alternative procedures; gradually increase the number of options; establish specific working and reporting patterns and criteria as each task is completed.

For standard score of 40 or less, establish clearly stated objectives but permit choice of resources, procedures, time lines, reporting, checking, etc.; permit choice of environmental, sociological and physical elements; provide creative options and opportunities to grow and to stretch talents and abilities; review work at regular intervals but permit latitude for completion if progress is evident. Some employees may not prefer structure but require close supervision.

9. LEARNING ALONE/PEER-ORIENTED LEARNER

For standard score of 40 or less, encourage use of self-designed objectives, procedures and evaluations before the supervisor assesses effort; permit self pacing and achievement beyond department goals; encourage creativity when it is evidenced; such adults work well alone rather than on committees or in groups.

For standard score of 60 or more, pair or team this person with colleague-oriented or authority oriented individuals that complement his/her sociological characteristics, e.g., prefers to work with colleagues, is team-oriented with a small group, and so on. Encourage colleague meetings and planning; permit these individuals to evaluate each other individually
and in groups; seek group suggestions and recommendations; use small-group training techniques.

10. AUTHORITY-ORIENTED LEARNER

For standard score of 60 or more, place these employees near appropriate instructors or supervisors and schedule numerous meetings among them; plan to visit and check work often; provide frequent feedback through the person’s perceptual strengths.

For standard score of 40 or less, identify the person’s sociological characteristics, and permit isolated achievement if self-oriented, worker groupings if colleague-oriented, or multiple options if learning in several ways is indicated.

11. SEVERAL WAYS

For standard score of 60 or more, provide opportunities for a variety of working patterns for the same employee, i.e., alone, with colleagues, with supervisors; use varied resources.

For standard score of 40 or less, permit the person to work in the sociological pattern most preferred. If none are strong, permit options. Recheck self-orientation and motivation, responsibility, and persistence. Utilize patterns and routines.

12. AUDITORY PREFERENCES

For standard score of 60 or more, use tapes, videotapes, records, radio, television, and precise oral directions when giving assignments, setting tasks, reviewing progress, using resources or for any aspect of the task requiring understanding, performance, progress, or evaluation.

For standard score of 40 or less, use resources prescribed under the perceptual preferences that are strong. If none are 60 or more, use several multisensory resources such as computers, videotapes, sound filmstrips, television, and tactual/kinesthetic materials. Suggest this person read and take notes before listening to lecture or audio management resources.

13. VISUAL PREFERENCES

For standard score of 60 or more, use pictures, filmstrips, computers, films, graphs, single concept loops, transparencies, diagrams, drawings, books, and magazines; provide resources that require reading and seeing; use programmed learning (if in need of structure) and written assignments and evaluations. These individuals should read the material before hearing a lecture.

For standard score of 40 or less, use resources prescribed under the perceptual preferences that are strong. If none are 60 or more, use several multisensory resources such as computers, videotapes, sound filmstrips, television, and tactual/kinesthetic materials. Suggest that this person listen to lecture and take notes before reading required materials.
14. TACTILE PREFERENCES

For standard score of 60 or more, use manipulative and three-dimensional materials; resources should be touchable and movable as well as readable; allow these individuals to plan, demonstrate, report, and evaluate with models and other real objects; encourage them to keep written records.

For standard score of 40 or less, use resources prescribed under the perceptual preferences that are strong. If none are 60 or more, use several multisensory resources such as computers, videotapes, sound filmstrips, television, and real-life experiences such as visits, interviewing, building, designing, and so on. Note-taking and manipulatives will be less effective than readings and lectures.

15. KINESTHETIC PREFERENCES

For standard score of 60 or more, provide 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.

For standard score of 40 or less, use resources prescribed under the preferences that are strong. If none are 60 or more, use several multisensory resources such as computers, videotapes, sound filmstrips, television, and tactual/manipulative materials.

16. REQUIRES INTAKE

For standard score of 60 or more, provide frequent opportunities for nutritious food breaks, food at work station, beverages at desk, and so on.

For standard score of 40 or less, no special arrangements are needed.

17. EVENING/MORNING

For standard score of 60 or more, permit scheduling of difficult tasks in morning. Take advantage of the strongest segment of the time energy curve for morning. If possible, allow self-scheduling before normal working hours if desired by employee.

For standard score of 40 or less, permit scheduling of difficult tasks in evening. Take advantage of the strongest segment of the time energy curve for evening. If possible, allow self-scheduling after normal working hours if desired by employee. Flex-time self-scheduling will greatly enhance productivity for employees scoring above 60 in any of the areas related to time preferences.
18. LATE MORNING

For standard score of 60 or more, permit scheduling of difficult tasks in late morning. Take advantage of the strongest segment of the time energy curve for late morning.

For standard score of 40 or less, permit scheduling of difficult tasks in the strongest segment of the time energy curve.

19. AFTERNOON

For standard score of 60 or more, permit scheduling of difficult tasks in afternoon. Take advantage of the strongest segment of the time energy curve for afternoon.

For standard score of 40 or less, permit scheduling of difficult tasks in the strongest segment of the time energy curve.

20. NEEDS MOBILITY

For standard score of 60 or more, provide frequent breaks, assignments that require movement to different locations, and schedules that build mobility into the work/learning pattern; require results, not immobility.

For standard score of 40 or less, provide stationary desk or work station where most of the individual’s responsibilities can be completed without requiring excessive movement.
APPENDIX E. PEPS SURVEY
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</table>
45. The one job I like doing best is one I do with a group of people.
46. I am uncomfortable when I work or try to study in a warm room.
47. I prefer to have teachers or supervisors set deadlines for my work.
48. I like to eat while I'm concentrating.
49. I prefer completing one thing before I start something else.
50. It is difficult for me to start a new task before I finish the task I am doing.
51. I really enjoy movies.
52. I have to be reminded to do things I've said I would do.
53. I work best when the lights are shaded.
54. I prefer that persons in authority stay away until I have completed my work.
55. I keep trying to accomplish a task even if it appears that I may not succeed.
56. I like to learn about something new by hearing a tape or a lecture.
57. I feel I am self-motivated.
58. The one job I like doing best is one I prefer doing alone.
59. Eating something would distract me when I'm working.
60. My performance improves if I know my work will be checked.
61. I prefer to work with music playing.
62. I stay at a task until it is finished, even if I don't like what has to be done.
63. I learn best by being directly involved in what I am doing.
64. I always do the best I can.
65. I prefer to learn how to do a new task by actually doing it.
66. I often read in dim light.
67. If I have to learn something new, I like to learn about it by reading.
68. I prefer someone else carefully outline how a task should be done.
69. I would rather start work in the morning than in the evening.
70. I constantly change positions in my chair.
71. The things I remember best are the things I hear.
72. I like my instructor(s) or supervisors to recognize my efforts.
73. I learn better by reading than by listening to someone.
74. I get more done in the afternoon than in the morning.
75. I can block out most sound when I work.
76. I really like to build things.
77. I prefer to work under a shaded lamp with the rest of the room dim.
78. I choose to eat, drink or chew only after I finish working.
79. I remember things better when I study in the evening.
80. If I have to learn something new, I like to learn about it by seeing a movie.
81. I feel good when my spouse, colleague or supervisor praises me for doing well at my job.
82. I prefer a cool environment when I try to study.
83. It's difficult for me to block out sound (music, TV, talking) when I work.
84. I would rather learn by experience than by reading.
85. I like being praised for a job well done.
86. It's difficult for me to sit in one place for a long time.
87. I like to have something to drink when I work.
88. I enjoy doing experiments.
89. If a task becomes very difficult, I tend to lose interest in it.
90. I can't concentrate best in the evening.
91. I prefer to study with someone who really knows the material.
92. I often change my position when I work.
93. I would work more effectively if I could eat while I'm working.
94. If I can go through each step of a task, I always remember what I learn.
95. I learn better when I read the instructions than when someone tells me what to do.
96. I only begin to feel wide awake after 10:00 A.M.
97. I often complete unfinished work on a bed or couch where I can recline.
98. I often wear a sweater or jacket indoors.
APPENDIX F. NORMALITY TEST FOR SAMPLE
Table F.1. Descriptive statistics for the histograms of the factor scores

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<th>Statistics</th>
<th>A-R Factor score 1 for analysis 1</th>
<th>A-R Factor score 2 for analysis 1</th>
<th>A-R Factor score 3 for analysis 1</th>
<th>A-R Factor score 4 for analysis 1</th>
<th>A-R Factor score 5 for analysis 1</th>
<th>A-R Factor score 6 for analysis 1</th>
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</tr>
</tbody>
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*Multiple modes exist. The smallest value is shown.
Figure F.1. Normality tests for factor scores of sample
BIBLIOGRAPHY


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