Environmental engagement demand differences within and among Holland academic environments

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ENVIRONMENTAL ENGAGEMENT DEMAND DIFFERENCES WITHIN AND AMONG HOLLAND ACADEMIC ENVIRONMENTS

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A dissertation submitted in partial fulfillment of the requirements for the

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ABSTRACT

Environmental Engagement Demand Differences Within and Among Holland Academic Environments

by

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College and university administrators have increased the use of measurements of student engagement to gauge the levels on their campuses. However, little research measures student engagement levels among different academic environments or different academic majors. Some research has been done that used Holland’s theory of person/environment fit, and accompanying Hexagonal model, as a means to compare differences among academic environments. However, the validity of the assumptions that the model is based on has not been examined, nor the validity of the grouping of academic majors into environments.

The data set used for this study is the 2005 National Survey of Student Engagement (NSSE). Multivariate analysis of six academic environments, comprised of 25 academic majors, found mixed results concerning the validity of Holland’s hexagonal model and its use as a categorization to compare academic environments. Cluster analysis of 25 academic majors revealed mixed results concerning the grouping of majors into Holland assigned academic environments.
DECIDCATIONS AND ACKNOWLEDGEMENTS

I dedicate this work to my parents, Larry and Faithe Lester. I completed this work because of their love, support, and the work ethic they instilled in me. Dad taught me how to think through all things. Mom emphasized the importance of hard work. I am glad they are my parents, for together they shaped me into who I am today.

I thank my committee chair, Mario Martinez, for all the years he has helped me. I thank my committee members: Vicki Rosser, Bob Ackerman, and CarolAnne Kardash for reading my drafts and the input I received from them. Finally, I thank Dan Gianoutsos and Brandy Smith, we went through this program together and for that I am grateful.
PREFACE

This study slowly grew out of my interest in differences among the academic disciplines that populate our colleges and universities. Early in my program I was brainstorming with Dr. Ackerman in his office and he suggested I consider the National Survey of Student Engagement as a data set for my research. Five questions on this survey are, essentially, student assessments of academic environmental demands. I found these questions as a way to examine some interesting differences among academic majors and environments. Once I identified the NSSE questionnaire, the missing piece of the dissertation was a theory by which to organize the information. As I was reading articles in the Graduate Student Lounge of UNLV’s Lied Library one evening, I came across Holland’s Theory of Person Environment fit and the Hexagonal Model. With this final addition all the necessary pieces were in place. What followed were two years of work that culminated with this research.
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CHAPTER 1

STUDENT ENGAGEMENT AND ACADEMIC ENVIRONMENTS

An educated population yields individual and societal benefits. Individuals and society benefit from the positive outcomes students demonstrate after attending an institution of higher education. Positive outcomes include such benefits as increased civic engagement to enhanced personal and social financial gain (Bowen, 1977). A growing area of interest among higher education professionals is the potential that increased student engagement levels has to improve students’ learning, retention, and completion—and thus the positive outcomes associated with college attendance and completion. It then follows that the more knowledge we possess of effective educational practices that encourage student engagement the more benefits will accrue to individuals and society. Broadly speaking, several questions arise in the quest to improve student engagement: How can colleges and universities increase engagement? Do the various academic majors that compose college and university campuses differ in their ability to engage students? Are there similarities among different groups of academic majors in how they engage students? Do different groups or academic majors engage students in different ways, cognitively or behaviorally, for example?

A number of researchers (Smart, Feldman, & Ethington, 2000; Smart, 2008; Smart, Ethington, Umbach, & Rocconi, 2009) have examined measures of engagement across different majors or groups of majors. Majors that are grouped together according to some commonality are often referred to in the literature as academic environments or academic disciplines (see definition of terms at the end of the chapter). Some current research uses Holland’s (1966, 1973, 1985, 1997) model of academic environments to
investigate linkages between engagement and academic environments. A model developed by Biglan (1973) also allows researchers (e.g. Malaney, 1986; Bohr 1991) to create different academic groupings, which Biglan refers to as academic disciplines, and compare different student groups across a range of measures. Although researcher’s (Smart & Elton, 1982; Muffo & Langston, 1981) have empirically validated Biglan’s model, studies that utilize Holland’s academic environments do not test the validity of the model’s assumptions. Holland’s theory is in fact useful in that it provides a categorization to compare majors and academic environments across different measures. It is important to examine whether any engagement comparisons across academic environments align with Holland’s model since he offered a particular scheme for relating those academic environments. In addition, the exercise of comparing academic environments across newly emerging conceptions of engagement is an area of research worthy of consideration.

**Problem Statement**

One oversight in the literature is that there are no studies comparing academic majors and environments on aspects of engagement that address learning or cognition as defined by recent engagement surveys. Engagement is an important construct in higher education research because increases in engagement appear to lead to increases in positive student outcomes. Since engagement is reasonably linked to learning and positive outcomes, it stands to reason that studying engagement generally and specifically is a valid research. However, engagement is a multifaceted concept (Krause & Coates, 2008). While there is a depth of literature on engagement as a singular concept, there is little research that explicitly acknowledges the multidimensionality of engagement and
delimits the term to make comparisons across academic environments more pointed and meaningful. Research by Biglan (1973) and Holland (1966, 1973, 1985, 1997) do provide theories by which to compare engagement differences across academic environments. Current research (Smart et al., 2000; Smart, 2008; Smart et al., 2009) does not cover critical aspects of the engagement concept and focuses on Holland’s theory and Hexagonal model while assuming the validity of Holland’s model. The National Survey of Student Engagement (NSSE) gathers information on multiple aspects of engagement and therefore provides an opportunity to fill this gap. The literature review raised several questions concerning Holland’s theory and model, as it relates to academic environments: Are engagement differences among environments in accordance with Holland’s model? Are academic majors homogenously grouped into environments, according to the HTS scalelet? Are the assumptions that Holland’s model is built on sound? This research begins to answer these questions.

The literature on engagement does attempt to connect engagement to certain outcomes. Researchers are looking into ways to increase student engagement levels to “add value” to the educational experience, and help students benefit from a college education. Pascarella & Terenzini’s (2005) literature review found that student engagement is known to improve student learning and cognitive growth. An empirical study by Kuh, Cruse, Shoup, Kinzie, and Gonyea (2007) of over 11,000 first year and senior year students’ responses to The College Student Reports of 2002 and 2003, which are produced by NSSE, and other background data, reveal that the grades of engaged students are higher than those who are not engaged, and engaged students are more likely to continue their university education. Other researchers conclude that faculty
engagement with students improves students’ learning (Ullah & Wilson, 2007; Kuh & Gonyea, 2005).

A growing area of research examines aspects of student choice of academic environments and the influence of academic environments on students (Pike, 2006a; Pike, 2006d; Nelson Laird, Shoup, Kuh, & Schwarz, M.J., 2008). A theory of academic environments, outlined in The Education Opportunities Finder (Rosen, Holmberg, Holland, 1997), was developed by Holland (1966, 1973, 1985, 1997) out of his theory of person/environment fit. This theory is gaining increased use as a means by which to compare student outcomes across academic environments (Smart et al., 2000; Smart, 2008; Smart et al., 2009). An example of an academic environment is Holland’s grouping of majors into an “Investigative” environment. It was created by combining such majors as finance, biology, chemistry, math, physics, economics, civil engineering, and pre-medicine because of the “Investigative” nature of each discipline.

Administrators and researchers measure college student engagement levels in order to better understand students and their self-reported levels of engagement. Surveys such as The College Student Report (2005) examine engagement levels among university and college students. Importantly, The College Student Report also presents an opportunity to more specifically study engagement since it is comprised of a collection of questions related to cognitive engagement. Within the survey questions are categorized sets and groupings, called benchmarks and scalelets, which examine specific aspects of engagement. For example, five questions within what is called the Level of Academic Challenge Benchmark ask students to evaluate coursework demands on student memorization, analysis, synthesis, making judgments, or applying theories. The Higher-
order Thinking Skills (HTS) scalelet, a subset of questions that comprise the Level of Academic Challenge Benchmark, examines academic environmental demands on students’ higher-order thinking skills. The availability of data on specific aspects of student data, combined with the existing frameworks that categorize academic majors by environments, presents an opportunity to fill a specific gap in the literature: to examine aspects of engagement related to cognition and learning across academic environments while testing the validity of the very models that categories majors into environments. Holland’s model is drawing an increased amount of attention, but the basic assumptions of the model have not been examined. For this reason, Holland’s model will serve as the theoretical framework for this study so some of the assumptions may be examined.

**Theoretical Framework for the Study**

The academic core of colleges and universities is comprised of a diverse collection of academic environments. Academic environments are a collection of academic majors, tied together by some conceptual commonality. Despite some conceptual commonalities, each academic environment is comprised of a diverse assortment of academic majors, each with its own assortment of students and faculty. Likewise, students and faculty who are drawn to a particular field of study bring with them a diversity of interests and pursuits. To better understand higher education, there is a growing body of research that looks to understand and describe the differences among students and faculty within and among these environments.

In order to examine the influence academic environments have on students, a first step is to describe the characteristics of the academic environments. A theoretical model developed by Holland (1966, 1973, 1985, 1997) is used by researchers as a way to group
academic environments. Holland’s theory is one of person/environment fit, and it is gaining increasing popularity among higher education researchers. While originally designed as a vocational placement tool, this theory is now being used as a way to analyze and compare students of different academic environments, across a range of characteristics. Recent studies using Holland’s model have, from a very broad and general perspective, examined the impact environments have on student learning (Feldman et al., 1999; Smart, 2008) and student selection of academic majors (Pike, 2006a; Pike, 2006d).

Holland’s theory of academic environments (Rosen et al., 1997) is based on personality similarities. Holland’s theory states that each academic area, be it major or environment, is made up of like-minded individuals who create unique environments influenced by the personalities of the individuals who populate it. From his theory, Holland derived a model whereby academic majors are grouped into one of six broad academic environments. Academic majors are grouped into environments based off of theorized environmental characteristics. Holland’s model groups the six environments around a circular hexagonal model, with similar environments next to each other. Environments that are increasingly dissimilar are more distant from each other, on the circular model. The theory further states that each environment has a unique influence on the people that interact with it; an individual’s behavior becomes a function of their personality interacting with an environment. Similarly, environments are also influenced by the individuals that populate them or interact with them.

The influence individuals have on environments, and environments on individuals, is studied in the fields of sociology, psychology, and organizational and
vocational settings (Smart et al., 2000). However, Feldman, Smart, and Ethington (1999) note the paucity of educational studies that take into account the impact of academic environments on student change or stability. “The infrequency of such studies may be due to the sheer conceptual and logistical difficulty of obtaining longitudinal measures of success, performance, and achievement” (Feldman et al., 1999, p. 644).

The notion of academic environments is the core theoretical starting point for this research. The concept of academic environments is, however, enriched by saying something about those environments relative to each other, which requires a basis for comparison. For this study, the measure by which to compare academic environments is engagement.

To clarify the term, engagement can be divided into three broad categories: behavioral, emotional, and cognitive (Fredericks, Blumenfeld, & Paris, 2004). Of these three broad categories, cognitive engagement is the focus of this research. Cognition may be reasonably associated with measures of higher-order thinking skills found in the literature, and higher-order thinking skills have been, in turn, associated with increased student engagement levels (Ahlfeldt, Mehta, & Sellnow, 2005). Higher-order thinking skills refer to the mental functioning of students, and their effort to comprehend complex ideas and master difficult skills (Fredericks et al, 2004). Pike (2006b) refers to higher-order thinking skills as students’ conscious intent with course content to memorize, analyze, synthesize, make judgments, and apply theories.

NSSE’s 2005 version of The College Student Report, a survey of student engagement, offers a method by which to compare proxy measures of cognitive engagement levels among students enrolled in different academic environments. A set of
questions taken from The College Student Report was assembled by Pike (2006b) into a Higher-order Thinking Skills (HTS) scalelet. This scalelet examines students’ higher-order thinking skills engagement in relation to their coursework. This set of questions asks students to measure the extent to which their coursework emphasizes memorization, analysis, synthesis, making judgments, and applying theories or concepts. Admittedly, the wording of these questions asks students to rate higher order thinking skills that their coursework expects of students, as opposed to asking students to rank the level of higher order thinking skills that they personally possess. These questions present a starting point for initiating this study, as they could be reasonably conceived of as proxy measures for cognitive engagement. This is particularly true if the students who answer the questions are far enough along in their degree majors such that they would have logically had to successfully utilize those higher-order thinking skills required by their coursework to reach a certain stage in their college careers.

**Purpose of the Study**

The purpose of this study is to compare one aspect of engagement, as measured by higher-order thinking skills, among university academic environments and academic majors. The study also investigates the validity of Holland’s model of academic environments in terms of the model’s stated relationship, or assumptions, between and among the various academic environments that define it. Despite the growing use of Holland’s model of academic environments, no recent research has examined the validity of Holland’s model. Importantly, the commentary on the validity of Holland’s model in this study is confined to those engagement measures across which the environments are compared—the HTS scalelet and five questions associated with it.
Need for the Study

The literature review yielded no studies that focus exclusively on comparing the higher-order thinking skills of students across majors or academic environments. The need for additional research into whether different academic environments require students to employ different aspects of higher-order thinking skills will help align student strengths and interests with different fields of study. However, national surveys such as The College Student Report produce results that take into consideration student responses from whole institutions, while not directly considering engagement differences among groups of students who comprise different academic majors or academic environments (which are comprised of groups of majors).

Holland’s grouping of academic majors into environments raises the question of whether majors are accurately grouped together into the theoretically established academic environments, or whether the theoretically established environments actually group similar majors. Further, if environments are uniformly similar on one or more characteristics or measures, is there evidence that majors within each of the six Holland academic environments place demands on students in an environmentally consistent and unique way? One way to examine this question is to compare students’ assessments of various measures across different academic majors or environments.

Studies that use Holland’s theory of academic environments make the assumption that the Hexagonal model is a valid grouping of academic majors within purposely placed environments. To date, I have found no study that questions or examines the validity of Holland’s grouping of academic environments or of academic majors into broader academic environments. While I used Holland’s model as an initial guide to compare
specific aspects of engagement, I also address the “validity gap” by comparing my results with Holland’s theorized grouping of majors and placement of environments relative to each other.

**Research Questions**

Three research questions fulfill the purpose of this study. The first two research questions compare academic environments with the HTS scalelet and five individual questions associated with the scalelet. The final research question examines if academic majors group according to Holland’s defined environments on the HTS scalelet. The research questions are as follows:

1. Are there engagement demand differences among the six Holland academic environments on Pike’s HTS scalelet?
2. Are there engagement demand differences among the six Holland academic environments on any of five individual items associated with Pike’s HTS scalelet?
3. How do 25 academic majors group according to the HTS Scalelet?

The first two questions provide a basis for comparing academic environments and the theorized position among each other on the Hexagonal model. The last question, along with the results of the first two questions, allow for the comparison of the study’s results against Holland’s predicted placement of the various academic majors relative to their placement within environments.

**Significance of the Study**

The results of the study will enhance our understanding of how different majors and environments vary across one aspect of engagement. The process of describing higher-order thinking skills engagement characteristics within environments will help
researchers and practitioners understand which aspects of engagement are emphasized in different academic majors. Such research will be helpful for practitioners who wish to better align students’ abilities, propensities, or interests with academic majors that are compatible with a students’ personality type, and/or to more effectively predict beneficial alignment of students with academic environments. Additionally, results of this study may be used by faculty within environments as a tool to assess and possibly adjust environmental engagement demands on students.

The potential significance of this research for academicians is in the confirming, challenging, revising, or refuting Holland’s model of academic environments, as it pertains to higher-order thinking skills engagement. Consequently, this research will advance the study of higher education by potentially giving researchers a validated or adapted tool by which to study higher-order thinking skills demands on students across various majors and environments.

**Assumptions**

The HTS scalelet and the five questions drawn from The College Student Report are assumed to represent measures of environmental demands on students. This study does not attempt to validate the HTS scalelet or any of the five individual questions. It is therefore assumed that these measures are reasonable proxies for environmental engagement demands as they relate to cognitive engagement. As such, these assumptions are presumed to represent a reasonable starting point for understanding engagement differences across academic majors and academic environments. The study will focus on the HTS scalelet because of the relationship that higher-order thinking skills have with student learning.
The set of questions on the HTS scalelet asks students to measure the levels their course work emphasizes memorization, analysis, synthesis, making judgments, and applying theories or concepts. Admittedly, the wording of these questions in the College Student Report asks students to rate higher order thinking skills that their coursework expects of them, as opposed to asking students to rank the level of higher order thinking skills that they personally possess. It is assumed that these questions are reasonable proxy measures for higher-order thinking skills. This assumption is also made in light of the respondent data used for this study—college seniors. It is assumed that college seniors are far enough along in their degree majors to accurately assess the environmental demands placed on them.

An assumption is made that seniors are largely enrolled in courses of their chosen major and then, on the NSSE survey, evaluate environmental demands of their stated major. The College Student Report questions examined in this study are student assessments of all their senior year courses, with no distinction of whether student assessed courses are courses of their stated major. Finally, these questions may address some aspects of student cognition, or cognitive engagement, but the questions will not be referred to as absolute measures of cognitive engagement. The HTS scalelet and five NSSE questions used for this study are not specifically and unconditionally called cognitive engagement. The questions measure student perceptions of environmental demands on their higher-order thinking skills and not, necessarily, actual cognitive engagement levels. Thus, the questions may be proxy measures for aspects of cognitive engagement but not actual measures of it.
Limitations of the Study

There are several noteworthy limitations to this study. First, the study only uses data on higher-order thinking skills and does not address any other types of engagement differences across majors and environments. This limitation prevents any comprehensive or singular view commentary on engagement, as is commonly found in the literature. In turn, any proposed revision to Holland’s model is only suggested within the context of higher-order thinking skills engagement.

In addition, several features of Holland’s theory are not considered in this study. Measuring the mutual effects faculty and students have on their academic environments, and environmental effects on them, is beyond the scope of this study. Composite and individual score comparisons have been broken down into comparisons of only adjacent and opposite environments, as defined by Holland’s Hexagonal Model. Those environments most alike are adjacent to each other, while those theoretically exhibiting the most differences are opposite. Each environment has two adjacent environments and only one opposite environment. Holland makes the distinction that environments increasingly differ from each other the further they are removed from each other on the Hexagonal model. Only combinations of adjacent and opposite environments are compared in this study, in light of the descriptive nature of the study, and for simplification of data analysis, which could easy turn unwieldy if all distinctions and combinations were compared.

Delimitations

The College Student Report, administered by NSSE, only measures first year and senior students attending four year universities and colleges. Students attending
community colleges and vocational-technical colleges are not included in this data set. Only three proprietary schools are included in this study. Likewise, this study represents a limited number, 529, American and Canadian colleges and universities. Only responses from seniors, pursuing only one stated major, is used in this analysis. Single major seniors will only be examined since the purpose of this study is to gauge environmental engagement demands on students.

Definitions of Terms

- *Academic environment*: A collection of disciplines or majors combined by some commonality (Rosen, Holmberg, & Holland, 1997)

- *Academic discipline*: A collection of majors under a general field of study such as education, chemistry, or engineering. Within each discipline a subset of majors are offered. For example, the discipline of engineering is comprised of mechanical and electrical engineering majors.

- *Academic major*: Specific individual majors, such as a student who is earning an elementary education degree or a biological chemistry degree.

- *Benchmarks*: Five question sets, comprised of 42 questions from The College Student Report, assess the level of use of educationally effective practices by students and institutions. These benchmarks measure “activities that research studies show are linked to desired outcomes in college” (NSSE, 2005b). The five benchmarks are: Level of Academic Challenge, Active and Collaborative Learning, Student-Faculty Interaction, Enriching Educational Experiences, Supportive Campus Environments (NSSE, 2009b).
• **College Student Report**: A survey of college freshmen and seniors that measures their involvement with activities that improve learning and development. The College Student Report is frequently referred to as NSSE.

• **Congruent/incongruent**: The level of fit between personality traits and environment traits (Holland, 1966, 1973, 1985, 1997)

• **Consistent/inconsistent**: The level of trait similarities between personality or environmental types (Holland, 1966, 1973, 1985, 1997)

• **Differentiated/undifferentiated**: The level of definition of personality or environmental characteristics (Holland, 1966, 1973, 1985, 1997)

• **Engagement**: Formal and informal interactions of students with other students, faculty, or staff on a college campus. Fredericks, Blumenfeld, and Paris (2004) defined engagement by the broad categories of behavioral, emotional, and cognitive facets.
  
  o **Behavioral engagement**: Students’ in-class and out-of-class activities.
  
  o **Cognitive engagement**: The mental aspects of how students process information. It also involves self-regulated learning, metacognition, application of learning strategies, “being strategic” in thinking and studying, and putting in the effort to comprehend complex ideas and master difficult skills.
  
  o **Emotional engagement**: Students’ feelings about themselves, the institution, peers, faculty, or staff.

• **Higher Order Thinking Skills (HTS) Scalelet**: Created by Pike (2006b, 2006c). There are two versions of the HTS scalelet. One version is comprised of five questions from
the College Student Report, while another is composed of four questions from the College Student Report. The four question scalelet will be used for this study. The scalelet gauges student assessment of environmental demands on students’ higher-order thinking skills with course content. The scalelet measures engagement demands on students in the areas of memorizing, analyzing, synthesizing, making judgments, and applying theories. The difference in the two scalelets is that the four question scalelet omits the memorization question.

- **Indiana University Center for Survey Research (IUCPR):** An academic organization that “promotes student success and institutional effectiveness through research and service to postsecondary institutions and related agencies… The Center hosts the National Survey of Student Engagement (NSSE).” (Retrieved from: http://cpr.iub.edu/index.cfm)

- **The National Survey of Student Engagement (NSSE):** A national survey of student engagement levels. NSSE and the name of the survey, The College Student Report, are frequently used interchangeably.

- **Pike’s Scalelets:** Twelve question groups, comprised from 49 questions on The College Student Report, measure different aspects of student engagement. Created by Pike (2006b).

- **Opposite Environments:** Environments diagonal from each other on Holland’s Hexagonal Model: Realistic and Social, Investigative and Enterprising, and Artistic and Conventional are opposite from each other on the Hexagonal Model.

- **Student Outcomes:** “Attitudes, values, aspirations, personality characteristics, vocational choices, and incomes after graduations” (Endo & Harpel, 1982).
• **Questions:** Levels of engagement will be assessed using five questions from the 2005 NSSE survey. Definitions for the following five factors are taken from The College Student Report of 2005 (NSSE, 2005c).
  
  o **Analysis:** Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components.
  o **Application:** Applying theories or concepts to practical problems or in new situations.
  o **Making judgments:** Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions.
  o **Memorization:** Memorizing facts, ideas, or methods from course readings and repeat them in essentially the same form.
  o **Synthesis:** Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships.

**Organization of the Remainder of the Study**

The remaining chapters of this study contain the following information: Chapter 2 is a review of literature pertaining to student engagement, academic environment differences, and Holland’s theory. Chapter 3 outlines the statistical methodology used to analyze this data. Chapter 4 contains the results of the study. Chapter 5 covers the implications of the research findings and offers suggestions for further research.
CHAPTER 2
REVIEW OF RELATED LITERATURE

Hastings Rashdall (1936), the late university historian, said the university “represents an attempt to realize in concrete form an ideal of life…ideals pass into great historic forces by embodying themselves in institutions” (p. 3). Education is a deliberate act of shaping students to fit into an idealistic mold by educating youth to have certain social and aesthetic preferences (Bloom, 1987). Bowen (1977) narrowed the goals of higher education, and embodiment of societal ideals, to be “cognitive learning, effective development, and practical competence.” These three areas embody the basic human desire to educate a new generation to both perpetuate society and change it for the better.

One means by which to reach these goals is to increase among students the positive outcomes of postsecondary education. One factor that increases positive student outcomes is increased student engagement levels during the education process. Higher education leaders recognize this and increasingly use survey instruments, such as The College Student Report by NSSE, to gauge engagement levels among students and within institutions. Findings are then used to increase student engagement levels. To more specifically understand institutional practices that may increase engagement levels, some researchers compare academic environments and examine the different influences higher education academic majors and environments have on students. Holland’s theory of academic environments is one such theory used by researchers. Research using Holland’s theory offers great potential for educational improvement and change within higher education institutions, by offering researchers a categorization of environments by which to compare student outcomes across majors and environments. However, researchers who
have used the hexagonal model, derived from the theory, have assumed it the models validity.

Guided by the research study questions, my literature review will examine the multiple theories that categorize academic majors and the empirical findings comparing majors and environments. The literature review will also examine the validity of Holland’s’ model and its use as a lens through which to view and construct academic environments.

This chapter is divided into two sections. The first section will examine the various definitions and meanings of engagement found in the literature. The first section will conclude with a review of literature related to the educational benefits of engagement practices. The second section reviews the literature concerning academic environments, then focuses on Holland’s theory as a way to separate and categorize academic environments. This section will conclude with a highlight of gaps in the literature concerning the use of Holland’s theory of academic environments.

**Student Engagement**

Colleges are looking for ways to promote student success and help students gain the most from their higher education experience. Increasingly, institutions are looking for ways to encourage student engagement in formal curricular and informal co-curricular activities. Kuh et al. (2007) summarize research that identifies the key importance engagement behaviors have on student outcomes: “What students do during college counts more in terms of what they learn and whether they persist in college than who they are or even where they go to college” (p.7). As the benefits of engagement are identified,
educators place increased importance on improving student engagement to increase positive student outcomes.

A number of recommendations have been made to improve institutional, faculty, and student practices to increase student engagement. Influential works such as Chickering and Gamson's (1987), “Seven Principles for Good Practice in Undergraduate Education”, and Chickering and Kuh’s (2005), “Promoting Student Success: Creating Conditions so Every Student Can Learn” offer recommendations to improve general student learning and positive outcomes for students. The recommendations by these researchers describe ways for institutions to encourage student interaction, or engagement, with course content, faculty, staff, and other students.

The following section on student engagement is divided into three parts. The first section trisects the definition of engagement into behavioral, emotional, and cognitive aspects. The second section examines reasons for growing interest among national organizations, faculty, and administrators in increasing student engagement. The third section outlines some studies of student engagement, engagement practices that improve student learning, and a national test used to measure engagement levels as institutions of higher education.

**Engagement Defined: Behavioral, Emotional, and Cognitive Distinctions**

Engagement principles have been generally defined since the 1950s and 1960s, but not systematically categorized until recently. Engagement is still loosely defined, but a wave of current research is producing clarity around the construct. This section will take a brief look at the history of the concept of student engagement. Definitions of
engagement will be explored then specifically defined into behavioral, emotional, and cognitive realms.

Bowen’s (1977) classic work, “Goals: The Intended Outcomes of Higher Education” outlines generally agreed upon goals of higher education as well as the influence students’ behavior and environmental factors have on student outcomes. He narrows the general goals of higher education to “cognitive learning, effective development, and practical competence” (p. 27) and notes the complexity of learning and the influence of intertwining campus activities on students. “All three types of goals may be achieved in part from both formal instruction and extracurricular experience” (1977, p.27). Student academic achievement is positively influenced by formal activities such as faculty instruction (Ahlfeldt et al., 2005) and informal experiences such as living environments (Eck, Edge, & Stephenson, 2007). Faculty and staff formally engage students in class and informally outside of class. Students formally engage with other students in class and informally outside of class. Students also have different levels of motivation and implement different learning strategies. This complex set of behaviors and experiences influences student outcomes in a way that is generally described as “engagement.”

Bowen (2005) notes the growing importance engagement has as a distinguishing factor of the most educationally effective practices. Despite a growing focus by institutions to implement effective engagement practices, a unified definition of engagement has not congealed. Books and articles on student engagement range from anecdotes to empirical studies. An early edited work by Yamamoto (1968), *The College Student and His Culture: An Analysis* indirectly addresses engagement related issues. In
this work, the term student engagement is not used but the areas of engagement related to academic interest and inquiry are similar. Engagement related theories of the 1950s and 1960s, cited in this work, include thoughts on the effects on students of teaching methods, learning environments, student culture, peer influence, and extracurricular activities. Sandeen (2003) offers personal anecdotes of student engagement from a 38 year career as an academic affairs officer. However, his use of the term engagement is broad and includes any student interaction with faculty and administrators. To illustrate his personal role in student engagement, Sandeen describes letters of recommendation he wrote for several students. For one student he excused streaking past a sorority house as “an overly demonstrative display of flirtation” (p. 42). In another letter he dismisses psychedelic drug use as “vigorously exploring alternative lifestyles” (p. 43). Sandeen’s addition of these letters of recommendation, in a book on engagement, exemplifies the broad definitional range of the term engagement and the need to find a narrower use of the term for the purposes of this study.

The definition of engagement is being redefined in more specific ways as institutions examine multiple aspects of engagement in pursuit of increased levels on campus. Bryson and Hand (2007) note the complex nature of engagement and call for a multifaceted approach to improving student engagement. Coates and Krause (2008) call for a definition that encapsulates the multi-dimensional aspects of engagement. Glanville and Wildhagen (2007) acknowledge that there is a debate over how to define engagement, either as a single or multi-dimensional concept state. The authors conclude, “engagement should be measured as a multidimensional concept” (p.1019) divided into behavioral and psychological segments. Horstmanshof and Zimitat (2007) similarly
acknowledge the psychological and behavioral elements of engagement. Behavioral engagement refers to time spent studying or asking teachers for help, and psychological engagement refers to the value students place on learning. Vadenboncoeur (2006) outlines the extensively studied and categorized formal and informal student engagement literature. The author’s literature review found that formal student engagement pertains to in-class settings while informal engagement broadly encompasses out of class activities that range from after school programs to learning that occurs in any social setting. Vadenboncoeur stresses the importance of informal student engagement, since out-of-class activities constitute the bulk of students’ time.

Fredericks, Blumenfeld, and Paris (2004) propose a definition of engagement made up of behavioral, emotional, and cognitive dimensions. The broad definition of engagement formulated by Fredericks et al. (2004) is useful in clarifying the term engagement for the purposes of this study. Fredericks et al. (2004) conducted an analysis of the terms associated with school and student engagement and acknowledged that engagement is a vague catchall term. The authors’ 2004 work synthesizes a multitude of ideas and definitions surrounding engagement and condenses the term into three main categories: behavioral, emotional, and cognitive. These three categories in turn comprise the “meta construct” of engagement. While their paper addresses mostly K-12 applications of engagement theory, the conceptual definitions of engagement have implications for institutions of higher education.

**Behavioral engagement.**

Behavioral engagement consists of students’ involvement in academic and social activities. Three main categories of behavioral engagement include positive conduct,
involvement in learning, and participation in school related activities (Fredericks et al. 2004). Positive conduct includes following class rules. Involvement in learning and academic tasks includes student behaviors related to concentration, attention, persistence, effort, asking questions, and contributing to class discussions. Participation in school-related activities includes athletics or school government.

**Emotional engagement.**

Emotional engagement is comprised of students’ attitudes, interests, and values particularly related to positive or negative interactions with faculty, staff, students, academics, or the institution (Fredericks et al. 2004). Emotional engagement creates ties with institutions and builds students’ desire to work. Three main components include students’ affective reactions, emotional reactions, and school identification. Affective reactions in the classroom include student interest, boredom, anxiety, sadness, and happiness. Emotional reactions are positive or negative feelings toward the institution and instructors. School identification pertains to students’ feelings of belonging and importance within the institutional environment.

**Cognitive engagement.**

Cognitive engagement, according to Fredericks, et al. (2004), is divided into two components: psychological and cognitive. The psychological component encompass motivational goals and self-regulated learning as it relates to investment, thoughtfulness, and willingness to put in the effort to comprehend complex ideas and master difficult skills. The psychological component stresses students’ investment in learning and motivation to learn. The cognitive component involves self-regulated learning, metacognition, application of learning strategies and “being strategic” in thinking and
studying. Cognitive engagement and self-regulation are frequently used interchangeably in the literature. Cognitively engaged students are characterized by their hard work, enjoyment of learning, appreciation of challenging assignments, and self regulated behavior to meet course requirements.

Student engagement has taken on multiple definitions, but has become the standard term for those educational practices that aid student growth and learning. As engagement is increasingly viewed as an important part of educating students, a number of definitions for engagement have been formulated to target practices that will improve student outcomes. In pursuit of better educational experiences for students, and more positive learning outcomes, academics and institutions are assessing engagement behaviors to better assist student academic and social gains. Higher education institutions have many options to choose from to improve student engagement, for many factors affect student learning.

The Importance of Engagement

Interest in student engagement levels is growing as it is an acknowledged way for students to experience increased learning and improved outcomes from a university education. Faculty and administrators are focusing on improving student engagement. Growing research shows faculty and student practices influence the positive outcomes students receive from time spent attending an institution of higher education. This section outlines some benefits of student engagement, institutional practices that encourage engagement, and the shared responsibility of faculty and staff to encourage student engagement.
Educators and researchers acknowledge increased levels of student engagement have a significant positive influence on student learning and outcomes (Carini, Kuh, & Klein, 2006; Kuh et al., 2007; Glanville & Wildhagen, 2007). Student development theories such as Astin’s (1984) input-environment-outcome (I-E-O) model of student involvement and learning states that the quality and quantity of student interactions directly influences student levels of learning and development. Pascarella and Terenzini’s (2005) review of the literature support Astin’s theory and report “a substantial amount of both experimental and correlation evidence suggests that active student involvement in learning has a positive impact on the acquisition of course content” (p. 101). From a K-12 perspective, Glanville and Wildhagen’s (2007) statistical analysis of the National Educational Longitudinal Study of 1988 data reviewed answers from 12,210 10th grade students, and findings suggest student engagement decreases student dropout rates. The acknowledged benefits of engagement have led institutions to place greater emphasis on increasing student engagement, and evaluating students’ levels of engagement, in an effort to influence students toward gaining the most from college.

Educational organizations and individual researchers acknowledge the shared responsibility of faculty and professional staff to encourage engagement among students. Reports issued by national organizations such as the American College Personnel Association (ACPA) and the Joint Task Force on Student Learning acknowledge the shared responsibility of academic and non-academic staff for student learning (Bresciani, Zelna, & Anderson, 2004). The ACPA’s 1994 report, *The Student Learning Imperative: Implications for Student Affairs*, calls for student affairs staff to partner with students, faculty, and other staff to work together to improve student learning. The Joint Task
Force on Student Learning’s 1998 report, *Powerful Partnerships: A Shared Responsibility for Learning*, urges faculty and staff to strengthen student learning through a number of curricular and co-curricular practices.

Improving student learning is influenced by practitioners and the methods they use to engage student learning. Researchers such as Schroeder (2004) note that “promoting student learning is the responsibility of both faculty and student affairs educators” (p. 328). Engagement practices that stem from student, faculty, and staff actions are found to help students develop intellectually and personally (Ahlfeldt et al., 2005; Anderman & Kaplan, 2008; Astin, 1985; Eck et al., 2007; Gray & Madson, 2007; Reeve, Jang, Carrell, Jeon, & Barch, 2004, Kuh & Gonyea, 2005; Pascarella & Terenzini, 2005; Temple & Barnett, 2007; Ullah & Wilson, 2007; Umbach & Wawrzynski, 2005). Enhancing levels of student engagement is increasingly sought after by faculty and administrators because of the benefits it offers to student learning and development.

**Studies of Student Engagement**

A number of research studies examine the influence engagement behaviors have on students. This section first examines research studies of factors that influence student engagement, followed by a section that reviews faculty influences on student engagement levels. The third section reviews a national assessment test of student engagement. This third section concludes with a sample of studies that examine engagement differences among college student groups.

**Influences on student engagement levels.**

Numerous factors influence student change that comes about because of a college education. After a review of student outcomes, Pascarella (1991) comments that the “real
quality in undergraduate education resides more in what we do programmatically than in just what resources we have” (p. 459). Davis and Murrell’s (1993) study of 2,271 students attending both public and private universities who responded to the College Student Experiences Questionnaire used structural analysis to identify the primary reason for student gains. The authors found that it is the level of student effort placed into academic and social experiences that matters most. Kuh, Kinzie, Schuh, and Whitt (2005) explain the changes a student will undergo during college are due to the degree of involvement in academic and extracurricular activities. Pascarella and Terenzini (2005) note increased student effort with course content increases the “level of knowledge acquisition and general cognitive growth” (p. 608). In effect, students’ level of engagement greatly influences student learning and change, and institutions can implement programs that increase student engagement and learning.

Researchers also examine the influence of co-curricular factors on student engagement levels. Topics examined include the effects of spirituality, enrollment in living-learning communities, and interpersonal relationships has on engagement levels. Kuh and Gonyea (2005) t-test, ANOVA, and regression analysis of NSSE data of 149,801 college seniors, attending 461 colleges and universities, found student spirituality has a neutral to mild positive influence on engagement related behaviors. A study of 403 students at a regional southern university found residing in living-learning communities has a positive influence on the academic success of students who reside in them (Eck et al., 2007). Anderman and Kaplan’s (2008) literature review of academic motivation identified the important role interpersonal relationships play in encouraging student motivation and learning.
Faculty and engagement.

Faculty members play an important role in the quality and quantity of student engagement. Specifically, faculty behavior and instructional techniques have an influence on student learning. Identifying pedagogical strengthens and weaknesses in an environment, by identifying specific faculty behaviors, may lead to better learning outcomes among students within an environment. The following section outlines research findings and recommendations of ways faculty may improve student outcomes.

Studies by Ahlfeldt et al. (2005), Reeve, Jang, Carrell, Jeon, and Barch (2004), and Umbach and Wawrzynski (2005) found faculty instructional practices influence students’ level of engagement and learning. A correlation analysis of the Student Engagement Survey, administered to 1,831 students attending a Midwestern university, found student engagement increased when faculty increased use of problem based learning (PBL) in class (Ahlfeldt et al., 2005). An observational study of 20 Midwestern high school teachers revealed levels of student engagement were influenced by faculty motivating styles. Student engagement levels increase when students are given increased personal responsibility for learning and classroom activities (Reeve et al., 2004). An analysis of the 2003 NSSE data, as well as an additional questionnaire of faculty, found students’ engagement and learning increased when faculty members implemented active and collaborative learning techniques in the classroom; techniques that emphasized higher-order cognitive activities, faculty interaction with students, and academically challenging work (Umbach & Wawrzynski, 2005).

Research studies have shown that faculty practices, such as interacting with students, can positively influence student engagement levels and the positive benefits
associated with increased engagement. Ullah and Wilson’s (2007) study of 2160 first year and senior students, attending a Midwestern public university, who responded to the 2003, 2004, and 2005 NSSE survey, found students’ cumulative GPA was positively influenced by student/faculty interactions and student use of active learning techniques. Kuh and Gonyea (2005) found that students’ academic achievement is positively correlated with faculty interaction and the level of students’ social effort. Nelson Laird and Kuh’s (2005) exploratory factor analysis of 63,407 student responses to the 2003 NSSE survey, representing 437 colleges and universities, found student use of information technology positively correlated with engagement related behaviors such as interacting with faculty, collaborative learning, and being engaged in academic inquiry and challenge.

Pascarella and Terenzini (2005) reviewed past research on effective instructional practices. Their literature review found that challenging course work encourages cognitive growth; students working in cooperative learning groups learn more than those who do not; social and co-curricular factors influence students’ critical, analytical, and reasoning skills; instructors’ pedagogical practices can also influence students’ critical thinking abilities and; student-faculty out of class interactions influence students’ learning levels.

Based on research, literature review, and/or personal experience, researchers such as Nelson Laird, Suniti Niskode, and Kuh (2006), Fredericks et al. (2004), Schroeder (2004), and Chickering and Gamson (1987) offer suggestions of specific practices faculty and administrators may implement to encourage student engagement and positively impact student learning.
Nelson Laird, et al. (2006) administered the Faculty Survey of Student Engagement (FSSE) to 11,000 faculty from 109 public and private universities. Survey results found faculty who implement engagement encouraging practices in their instruction, such as engaging students in collaborative activities, analyzing complex scenarios, and developing students’ writing, can lead to improved student outcomes such as increased learning and higher GPA.

Fredericks et al. (2004) offer several recommendations for faculty to improve students’ behavioral, emotional, and cognitive engagement, which include: encourage student interactions with each other and the course content; develop classroom structures that encourage engagement; meet students’ individual needs by supporting autonomy, relatedness, and competence to encourage engagement; incorporate task characteristics that use authentic, complex, and meaningful learning versus rote learning; have high expectations of students, and assign them harder tasks.

Schroeder (2004) outlines ways colleges may improve student learning on campus through faculty and student affairs administrators’ encouragement of student engagement practices. Recommendations for student affair professionals include increased student interactions and responsibility. Residence halls may increase student interaction by turning them into “learning communities…fostered by commonality and consistency of purpose, shared values, and transcendent themes” (p. 331). Student affairs officers may encourage student engagement among on-campus communities by expecting students “to assume responsibility for most aspects of their social and physical environments” (p. 330).
Chickering and Gamson (1987) wrote “Seven Principles for Good Practice in Undergraduate Education” to identify educationally beneficial instructional practices. Chickering and Gamson’s “good practices” include: increasing discussions between faculty and students; increasing cooperation among students; high faculty expectations of students; implementing active learning techniques in instruction; supplying students prompt feedback for work completed; respecting students’ diverse talents; and respecting students’ diverse ways of learning. These seven practices encourage individual faculty to implement some basic instructional methods and expectations in their instruction, while supplying academic departments and institutions with specific ways to improve student education.

The National Survey of Student Engagement

Increasingly colleges and universities are assessing student levels of engagement. Educational institutions are using student self-assessment surveys to identify ways to enrich a campuses’ educational effectiveness for students. Kuh et al. (2005) define an educationally effective college or university as one that focuses “students’ energies toward appropriate activities and engage [sic] them at a high degree in these activities” (p.9). A first step in identifying whether students are involved in these activities, or practices, is for institutions or departments to assess where they currently are at in offering certain “value added” engagement activities, and how much students are using these engagement related activities.

Institutions are increasingly using surveys of student engagement to identify strengths and weaknesses of institutions’ engagement practices. The Indiana University Center for Postsecondary Research (IUCPR) administers The College Student Report,
also known as NSSE, to freshman and senior students at four year colleges and universities. NSSE was originally supported by a grant from the Pew Charitable Trusts. It is currently administered by IUCPR in cooperation with the Indiana University Center for Survey Research and the National Center for Higher Education Management Systems (NSSE, 2009d).

The purpose of NSSE is to measure students’ engagement behaviors such as time spent studying for class or the amount of interaction with other students, faculty, and staff. The NSSE survey (The College Student Report) also gathers information concerning students’ background, including degree major. Findings from the NSSE survey identify the status of institutions’ levels of student engagement and are used to improve practices that may increase engagement among students.

NSSE created Benchmarks and scalelets (groupings of test questions taken from The College Student Report) to measure particular aspects of engagement. For example, the Academic Challenge Benchmark is made up of 11 questions that ask students academic related questions. The Higher Order Thinking Skills (HTS) scalelet, a subset of the Academic Challenge Benchmark, is comprised of four questions taken from the test.

**Research that uses NSSE data.**

The College Student Report has created a large amount of information researchers use to study the college student experience. The following sampling of citations demonstrates the versatility of NSSE data as a means to empirically examine the college student experience, covering a variety of topics that include: engagement and its impact on college readiness (Kuh, 2007), instructional methods (Ahlfeldt et al., 2005), student learning (Carini et al., 2006), grades and persistence (Kuh et al., 2007), and faculty
influence on student engagement levels (Umbach & Wawrzynski, 2005). NSSE data are also used by researchers to identify characteristics among student groups, such as first generation and low income students (Filkins & Doyle, 2002), American and international students (Zhao, Kuh, & Carini, 2005), gender differences (Harper, Carini, Bridges, & Hayek, 2004), Greek letter students (Hayek, Carini, O’Day, & Kuh, 2002), and student athletes (Umbach, Palmer, Kuh, & Hannah, 2006).

A study conducted by Smart (2008) used NSSE data to examine the 2003 and 2004 survey results from 5,904 seniors. This research examined engagement differences among student groups using Holland’s theory of academic environments. Students enrolled in Artistic academic environments reported greater growth in the areas of critical and analytical thinking, and clear and effective writing, compared to students in Investigative, Social, and Enterprising environments. In line with this and other studies (Feldman et al., 1999; Smart et al., 2009; Choi Man, 1983; Martin & Bartol, 1986; Pike, 2006a; Pike, 2006b) my dissertation will use survey data to measure an aspect of the college student experience among academic environments.

Project Deep (Documenting Effective Educational Practice) (NSSE, 2009e), a recent project developed in conjunction with NSSE, the American Association for Higher Education, Lumina Foundation, and the Center of Inquiry in the Liberal Arts at Wabash College, was initiated to identify specific practices institutions use that encourage high levels of student engagement. It was created to document the practices of colleges and universities with high levels of student engagement and graduation rates. Project DEEP institutions were chosen because of higher than average levels of engagement, as measured by NSSE test results. Recommendations of this initiative call for faculty to
adapt instructional techniques to students’ multiple learning styles, provide prompt feedback to student work, and for students to take responsibility for their own learning (Chickering & Kuh, 2005).

**Summary of Engagement Literature Review**

The preceding literature review on student engagement found that engagement is an area of growing interest by both higher education practitioners and researchers. However, engagement is a term with a broad definition, which can make analysis of engagement related topics muddled by lack of clarity of the term. Studies that do look at student engagement have examined the influence of faculty, staff, the students themselves, and academic environments on student engagement and learning levels. As a means to measure student engagement levels, higher education institutions are increasingly using assessments of student engagement. Survey results from these assessments have been used by researchers to evaluate student engagement and learning levels. This literature review has found that there is no unified definition of engagement, though there have been efforts to consolidate the term.

**Academic Environment Differences**

Smart, Feldman, and Ethington (2000) note research literature from the mid-1960s to the 1990s shows declining use of academic environments as a means to help explain personal, attitudinal, or cognitive changes in students. The authors note understanding academic environments is vital to understanding how college environments change students by encouraging or discouraging behaviors. However, there is little research of “specific characteristics of individuals and their interactions with various aspects of their institutional settings. Differential patterns of change and stability
for students majoring in dissimilar academic programs is (at best) a secondary concern” (Smart et al, 2000, p. 26-27). To better understand the differences among academic environments, and ultimately further understanding of the effects of academic environments on students, a typology of academic majors will be defined from the literature and used for the purpose of this study.

The following section reviews research that has been conducted on academic disciplinary differences within and among academic environments. A number of studies have looked at differences within and among academic environments. Studies by Selah (2001), Hodgkins and Innes (2001), Derryberry, King, and Vendetti (2006), Peacock and Ho (2003), and Carini and Kuh (2003) looked at academic discipline differences. Student and faculty differences are reported in areas such as brain hemisphericity, attitudinal dispositions, differences in moral development, learning strategies, and student and faculty interaction levels.

A study by Selah (2001) of 429 students attending a large southern university, used McCarthy’s Hemispheric Mode Indicator to measure brain hemisphericity differences among students enrolled in different academic majors. Brain hemisphericity examines “right brain” and “left brain” dominance in processing information. Nonlinear thought and an orientation toward visual and spatial information processing is referred to as “right brain” dominant. “Left brain” dominance is characterized by linear thought processes and the use of language. One-way ANOVA results found students majoring in education, nursing, communication, and law were predominantly right brained; students majoring in business, engineering, and science were predominantly left brained.
Hodgkins and Innes (2001) and Livingston, Derryberry, King, and Vendetti (2006) examined different components of student engagement by discipline, ranging from measured differences in student attitudinal perspectives to the faculty/instructor role in affecting student engagement levels. A study of 391 Australian 1st year undergraduate students by Hodgkins and Innes (2001) used an ANOVA of questionnaire answers to identify environmental and ecological attitudinal differences among students in different academic disciplines. The authors note differences between students in “liberal” majors, such as sociology or environmental studies, and students in “conservative” majors, such as business or law. Students enrolled in “liberal” majors had more ecologically positive beliefs. Livingston, et al. (2006) used LSD pair wise comparisons, ANCOVA, correlations, and linear regression to analyze 151 student survey responses to examine differences in the levels of moral judgment development among students in the majors of education, psychology, and a composite grouping majors. The research identified no significant differences among the three groups.

Studies by Peacock and Ho (2003), and Carini and Kuh (2003) compare instructional differences among academic majors. Peacock and Ho (2003) looked at English language learning strategies of non-native speakers across eight disciplines. The authors found that students who were English majors used the most second language learning strategies and computing majors used the least. In a separate study, those most likely to enter the teaching profession (education majors), report lower levels of faculty interaction when compared to students in the physical sciences (Carini & Kuh, 2003).

In addition to studies that examine differences between academic majors, studies conducted by Allen and Bycio (1997), Marshall (2007), Murphy, Doucette, Kelleher,
Young (1997), Hativa and Birenbaum (2000), Smeby (1996), and Andersson (2003) have looked into differences within academic majors. Three studies examined GPA, standardized test scores, and cognitive perception differences among business majors with different areas of concentration. Allen and Bycio (1997) examined students’ GPA, SAT, and Major Field Achievement Test in Business scores, of students enrolled in a Jesuit university’s business college. Samples of 65 and 369 students reveal accounting majors have higher standardized scores on a business evaluation test and higher SAT scores than management, entrepreneurship, and marketing majors. A study by Marshall (2007) of 339 senior business majors at a medium-sized southeastern university used ANOVAs of GPA, SAT Math, and other test scores to examine differences among finance, accounting, marketing, and management majors. Marshall found finance and accounting majors have higher general GPA, capstone course GPAs, and SAT Math scores than marketing or management majors. Murphy et al. (1997) examined field independence/dependence among 110 business students enrolled at a Canadian university. Students with a field dependent mindset view content fields more holistically and interconnected. Field independent thinkers viewed a field of study as separate and not interacting with other fields. Murphy et al. found accounting majors to be more field-independent while management majors were more field dependent. However, Hativa and Birenbaum’s (2000) study of 175 Israeli undergraduate education and engineering university students found few disciplinary differences among students’ teaching and learning preferences. This final study’s findings has implications for my research in that previous research suggest differences will be found as a function of academic environments. However, this study found few differences.
Though most research on differences across academic environments focuses on students, some research addresses the differences among faculty from different academic environments. Smeby (1996) and Andersson (2003) measured differences between the number of hours faculty spend preparing for instruction, and differences between faculty definitions of student success. Smeby’s (1996) survey of 2115 faculty, from Norway’s four public universities, found faculty in the humanities and social sciences spend more time preparing for instruction and actual in-class teaching than faculty in medical or technological fields. Andersson’s (2003) study identified differences in how faculty from a Swedish university’s departments of Business Administration and Social Welfare view student success. The 10 Business Administration faculty regarded student success in terms of student cognitive gains, such as growth in logical ability, analytical skills, or skill in written communication. However, the 11 Social Welfare faculty rate student success using both non-cognitive criteria and criteria that considered combined cognitive and non-cognitive factors such as development of critical analysis and reflection, personal growth, or ability to work with others.

Models of Academic Environments

There are several theories that categorize academic environments by academic disciplines. Two prominent models addressing differentiated environments emerged in the early 1970s. Biglan and Holland separately introduced models to type environments into homogeneous subsets. The two theories differ in the approach used to categorize the environments. Biglan’s (1973b) typology groups academic disciplines according to curriculum into hard/soft, life/non-life, and applied/pure categories. Holland’s (1966, 1973, 1985, 1997) theory is different in that personality similarities are used to group
people into environments. Holland developed a vocational assessment tool to help match the compatibility of individuals to occupational environments. Later his theory was used to categorize academic majors into distinct environments.

In student success research and literature, Biglan’s (1973b) and Holland’s (1966, 1973, 1985, 1997) typologies of academic disciplines receive little attention as a means by which to study students. Researchers tend to use student theories that place the student as the unit of analysis — as opposed to Biglan’s and Holland’s approach to use the academic unit as the unit of analysis.

Smart et al. (2000) explain that the majority of current research on students uses a psychological social psychology perspective that focuses on “individuals and their interactions with various aspects of the institutional settings” (p. 26). This approach looks at student development as an individual process, with most research measuring student outcomes. Alternatively, Holland’s theory takes a sociological social psychology perspective and looks at the influence environments have on people. This sociological perspective allows researchers to identify, among other things, the “social pressures on new members to adhere to prevailing ways of thinking, feeling, and behaving found in the group” (Smart et al., 2000, p.19). This perspective also takes into consideration the influence of students’ personalities as a deciding factor in choosing an academic environment, as students chose academic environments with social settings sympathetic with their personality. From this perspective, descriptive studies of academic environments may help researchers identify how students and faculty within environments differ. A lack of inquiry into the differences among members of different
academic environments leaves a gap in our understanding of the potential force environments have to shape student behaviors.

**Biglan.**

A theory of academic environments developed by Biglan (1973a, 197b) has been used extensively to measure student and faculty differences within and among academic environments. Research based on Biglan’s environmental model is reviewed in the following section because it adds legitimacy to my current study using Holland’s model. The extensive number of studies that use Biglan’s academic environments, to view differences among student groups, have shown noteworthy differences within and among academic environments. The nature of the findings using Biglan’s model suggests that research into academic environmental differences using Holland’s model will offer further insight and understanding of academic environments and their influence on students.

Biglan (1973a, 1973b) developed a model to categorize the subject matter of the various academic departments. He used multidimensional scaling to separate discipline content into dimensions he labeled as pure/applied, hard/soft, life/non-life. Pure fields are theory based disciplines such as physics and mathematics. Applied fields are practitioner based disciplines such as nursing or home economics. Hard systems have a single paradigm, or a defined set of terms of discourse. Science based degrees are hard fields. Soft systems are non-paradigmatic and “the scholar must describe and justify the assumptions on which his work is based” (Biglan, 1973b, p. 211). Soft fields include the humanities and education. Hard/soft academic areas are further divided into two subsets of non-life/life systems. An example of a non-life system is geology, as it deals with non-
living matter. Forestry is a life system because it deals with living matter. Table 1 provides a visual categorization of academic majors using Biglan’s model. Biglan’s model of Academic Disciplines has been empirically validated by Smart and Elton (1982), Stoecker (1993), Creswell and Bean (1981), and Muffo and Langston (1981) among others.

Researchers using Biglan’s model have found differences among students and faculty within different academic environments that are consistent with Biglan’s environmental paradigm. Malaney’s (1986) study of 1,083 graduate students newly enrolled at a large Midwestern public university used linear regression and discriminant function analysis to identify graduate student grouping along Biglan’s dimensions in regards to citizenship, age, gender, level of degree being pursued, GRE score, and undergraduate GPA. A study of 290 students at a large public university, found students enrolled in pure fields were less likely to have naïve epistemological beliefs related to simple knowledge, quick learning, or certainty of knowledge than students in applied fields (Paulsen & Wells, 1998).

Bohr (1991) notes differences of test scores among students enrolled in different academic environments, as defined by Biglan’s model. Bohr’s analysis of 210 freshmen, attending an urban public university, used regression analysis of student responses to the Collegiate Assessment of Academic Environments. Analysis revealed enrollment in hard pure and hard applied courses contributed to improvements in math scores. Enrollment in applied science, pure math, and science courses also improved math scores. Applied science and pure humanity courses contributed to reading gains. However, Whitmere’s (2002) t-test comparisons of 5,175 student responses to the 1996 College Student
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<tr>
<td>Applied</td>
<td>Agronomy, Horticulture</td>
<td>Civil and Mechanical Engineering</td>
</tr>
</tbody>
</table>

(Biglan, 1973b)
Experiences Questionnaire, representing 38, 4-year institutions, found soft social science courses had a negative effect on critical thinking gains. Undergraduates in soft and pure fields engage in more information seeking activities than students in hard or applied fields. Trautwein and Lüdtke’s (2007) longitudinal survey of 2,854 final year German upper secondary students, and later college students, found that epistemological beliefs of college students differed among students enrolled in hard and soft majors. Students in hard majors had more naïve epistemological beliefs while students in soft majors had more sophisticated beliefs. Students in hard majors had higher levels of certainty of knowledge than students enrolled in soft majors. Similarly, Nelson Laird et al.’s (2008) study of 2005 NSSE data from 517 4-year colleges and institutions, reviewed responses from 80,124 seniors. The results found students in Biglan soft, pure and life fields utilized integration, reflection, and synthesis in their learning process more so than students in hard, applied, and non-life disciplines.

Researchers who used Biglan’s academic environment paradigm have noted differences among faculty working in diverse subject areas. Kreber and Castledon (2009) note differences between faculty in pure/soft and pure/hard fields. Faculty in pure/soft fields reflected on core beliefs of educational goals and purposes more than faculty in pure/hard fields. Creswell and Bean’s (1981) study of 2,274 tenured and non-tenured faculty, representing 158 American institutions, note increased distinctiveness among faculty as they are socialized into their respective disciplines. Discriminant analysis revealed research output (published articles and books) differed significantly between soft and hard disciplines. Smart and McLaughlin’s (1978) linear regression analysis of
1,320 faculty responses from a large research university, to the Faculty Activity Analysis, found salary reward structures for faculty varied by environment.

Findings by researchers using Biglan’s theory are mixed when comparing academic environment differences of students or instructional methods. Li, Long, and Simpson (1999) conducted a study of 694 seniors from a Midwestern Research I university. Structural equation modeling examined responses to the Senior Survey, a self-report of seniors’ educational success, found no difference between students in hard and soft paradigms on self-reported gains in critical thinking or communication skills.

Analysis of 101,710 student responses to the 1995 Instructional Development and Effectiveness Assessment did not identify differences in instructional methods among Biglan defined academic environments (Cashin & Downey, 1995). Despite a few limitations in identifying differences among academic environments, Biglan’s model has been used successfully to identify numerous differences among students and faculty of different academic environments.

Kolb and Becher.

Others beside Biglan who categorized academic disciplines include Kolb (1981) and Becher (1994). Kolb divided the learning styles of students and faculty in academic disciplines into concrete active, concrete reflective, abstract active, and abstract reflective. Becher describes faculty from different academic disciplines as belonging to their own ‘tribe’, each with their own culture, and calls for increased research into the differences and similarities of academic disciplines. Becher recognized the similarities between Biglan’s and Kolb’s theories and acknowledged the similar separation of disciplinary areas as outlined in Table 2.
**Table 2**  
*Biglan and Kolb Comparisons of Disciplinary Areas*

<table>
<thead>
<tr>
<th>Biglan</th>
<th>Kolb</th>
<th>Disciplinary Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Pure</td>
<td>Abstract Reflective</td>
<td>Natural Sciences</td>
</tr>
<tr>
<td>Soft Pure</td>
<td>Concrete Reflective</td>
<td>Humanities, Social Sciences</td>
</tr>
<tr>
<td>Hard Applied</td>
<td>Abstract Active</td>
<td>Science-Based professions</td>
</tr>
<tr>
<td>Soft Applied</td>
<td>Concrete Active</td>
<td>Social Profession</td>
</tr>
</tbody>
</table>

Adapted from Becher (1994)

**Holland’s theory of person and environment fit.**

At the same time Biglan introduced his model of typing academic environments, Holland (1966, 1973, 1985, 1997) developed a theory for vocational counseling that looked at the interconnection between personality and environment fit. This theory offers an explanation of how people choose environments that are similar to their personality type and illuminates factors of how environments reinforce or discourage certain behaviors. Holland’s theory is also used to increase understanding of college students and academic environments.

Holland developed his theory as a way to help people choose jobs they would find compatible and satisfying based on their personality type. “Orientations consistently imply that a person’s vocational interests flow from his life history and his personality…what we have called ‘vocational interests’ are simply another aspect of personality” (Holland, 1973, p.7). Holland proposed that by identifying a person’s traits, essentially aspects of personality, a vocational or educational environment hospitable to those traits can be identified and chosen by him.

Holland’s theory has four primary elements, termed “assumptions,” that revolve around six corresponding personality and environment types: realistic, investigative, artistic, social, enterprising, and conventional. The first assumption is that there are six
personality types: realistic, investigative, artistic, social, enterprising, or conventional. People with the same personality types have similar “interests, competencies, and dispositions, they tend to…seek out problems that are congruent with their interests, competencies, and outlook on the world” (1997, p. 3). According to Holland’s theory, people of similar personality types cluster together and create an environment that reflects the personality types of those that make it up. The second facet of Holland’s theory concerns the six environments previously listed. Different environments have different standards and expectations that reflect the common dispositions of the members.

The third element of Holland’s theory is the assumption that people look for environments that match their personalities in order to “exercise their skills and abilities, express their attitudes and values, and take on agreeable problems and roles” (1997, p. 4). Table 3 shows a listing of the personality characteristics of each environment, paired with the 25 majors selected for this dissertation. The fourth aspect speaks to the interaction between a person and his environment, and how this interaction ultimately shapes behavior. Indeed, behavior is a function of personality and environment. As an individual interacts with an environment, the environment in turn acts upon the individual, thereby influencing that individual’s behaviors.

Holland’s four primary assumptions are augmented by an additional five secondary assumptions. These secondary assumptions qualify the primary assumptions by taking into consideration the varying degree a person or an environment resembles one or more of the six types. The secondary assumptions are captured in the constraints of: consistency, differentiation, identity, congruence, and calculus. Consistency examines
## Table 3

**25 Academic Disciplines Sorted by Environment Types**

<table>
<thead>
<tr>
<th>Environment Type</th>
<th>Personality Characteristics</th>
<th>Academic Majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realistic</td>
<td>Enjoy concrete, practical activities</td>
<td>Electrical and mechanical engineering</td>
</tr>
<tr>
<td>Investigative</td>
<td>Enjoy analytical activities</td>
<td>Finance, biology, chemistry, math, physics, economics, civil engineering, and pre-medicine</td>
</tr>
<tr>
<td>Artistic</td>
<td>Emotionally expressive</td>
<td>Art, English, music, architecture</td>
</tr>
<tr>
<td>Social</td>
<td>Enjoy helping and teaching</td>
<td>Philosophy, political science, psychology, education, nursing</td>
</tr>
<tr>
<td>Enterprising</td>
<td>Motivated by financial gain or attaining organizational goals</td>
<td>Management, marketing, law, history</td>
</tr>
<tr>
<td>Conventional</td>
<td>Enjoy explicit, ordered jobs</td>
<td>Accounting</td>
</tr>
</tbody>
</table>

(Holland, 1997)

The similarity of a personality or environment type, as organized on the hexagonal model outlined in Figure 1. The hexagonal model positions personality/environment traits next to those traits that are most similar. For example, a person or environment can be made up of multiple traits. A person with a combination of realistic and conventional traits has a consistent personality because realistic and conventional traits are next to each other on the hexagonal model. An individual with both realistic and social traits has an inconsistent personality type because realistic and social traits are positioned opposite of each other on the hexagonal model.

The secondary assumption of differentiation measures how clearly defined a person or environment is in relation to the six traits. The more an environment or person resembles only one trait the stronger the differentiation to that particular trait. However,
if a person demonstrates characteristics of an equal number of all six traits then this person’s personality type has a low amount of differentiation. Next, identity is a persons’ or environments’ level of “clarity and stability” (Holland, 1997, p. 5) in regards to objectives, aptitudes, and focus. Personal identity is measured by how well defined the “goals, interests, and talents” are of the individual. The assumption of environmental identity is measured by the level of clarity in organizational processes pertaining to “goals, tasks, and rewards.” (Holland, 1997, p. 5)

The congruence assumption is the fit between a person and an environment. An artistic person in an artistic environment is a congruent fit. However, an artistic person in a conventional environment is incongruent because artistic and conventional are on opposite sides of the hexagonal model. Finally, calculus considers “the relationships within and between personality types or environments…ordered according to a hexagonal
model in which the distances among the types or environments are inversely proportional to the theoretical relationships between them” (Holland, 1997, p. 5).

Holland’s primary and secondary assumptions state that the closer the fit between a person’s personality and his environment the higher the levels of personal satisfaction for the individual and performance outcomes for the organization. In an academic setting, the outcomes of a proper personality/environment fit will theoretically lead to improved student academic performance and satisfaction. For example, realistic personality types will perform better and have more satisfaction in realistic environments. Likewise, realistic environments will operate better with members who have realistic personality types. A proper personality/environment fit will ideally lead to increased academic, vocational, personal, and interpersonal satisfaction.

Research using Holland’s theory.

Holland’s primary and secondary assumptions have been validated by a number of studies. Holland’s primary assumption of six personality types was validated by Choi Man (1983) and Martin and Bartol (1986). Choi Man (1983) found that high school students’ vocational interests were divided according to academic majors. Students majoring in the arts preferred artistic, social, or enterprising occupations. In contrast, students focusing on the sciences were interested in realistic or investigative occupations. Martin and Bartol (1986) found that Holland’s theory generally predicted MBA students’ area of concentration. A discriminant analysis of test scores of Holland’s Vocational Preference Inventory was found to predict MBA students’ choice of degree concentration. The study found social occupation interest scores of accounting or finance majors were lower than those of marketing or management majors. Realistic and
Investigative occupational interest scores were higher for information systems and management science majors than marketing or management majors.

Differences among academic environments are noted by Pascarella and Terenzini (2005). In a review of research findings, Pascarella and Terenzini note that students in investigative environments demonstrate higher gains in intellectual self-confidence and drive to achieve than do students from non-investigative fields. Students enrolled in enterprising disciplines show greater net gains in the areas of goal achievement and leadership abilities than do other students.

Holland’s model was made into a model of academic environments, as described in The Educational Opportunities Finder (Rosen et al., 1997). Based on personality characteristics, The Educational Opportunities Finder matches individuals’ with academic majors categorized into six academic environments. The validity of the secondary assumptions of Holland’s academic environments has been examined by a number of researchers. Feldman et al. (1999) cite studies that have measured aspects of student personality and environment fit. Feldman et al. (1999) found generally positive correlations in the literature between learning outcomes and occupational productivity for people with personalities that were congruent with their environment. Feldman et al. (1999) used Holland’s theory to assess academic disciplines’ varying degree of influence on student change and stability. Students with investigative personality types, enrolled in congruent academic environments, reported more growth in investigative abilities and interests than similar students enrolled in incongruent environments.

Pike’s (2006a) ANCOVA analysis of 631 students’ responses of the College Student Expectations Questionnaire (CSEQ), administered the summer of 2000
immediately before they entered a Midwestern university, found students choose academic disciplines along perceived fit with their own personality type. Pike’s (2006d) MANCOVA analysis of the aforementioned 2000 CSEQ data examined the influence of student personality types and college expectations on academic discipline selection. Pike found that students’ preconceived expectations influence their choice of academic discipline. Smart’s (2008) study of 5,904 student responses to The College Student Report of 2003 used a 4 X 2 MANOVA to compare the effects of consistent and inconsistent academic environments on student learning outcomes. The study found differences in levels of student learning varied depending upon which academic environment students were enrolled. Students enrolled in Holland defined consistent Investigative environments reported more growth in their ability to analyze quantitative problems than students in consistent Artistic, Social, or Enterprising environments. However, students in inconsistent Investigative environments did not differentiate from inconsistent Social or Enterprising environments on the ability to analyze quantitative problems. This lack of differentiation of the inconsistent Investigative environment to the inconsistent Social and Enterprising environment identifies differences between consistent and inconsistent environments that are in line with Holland’s secondary assumptions.

A similar study by Smart et al. (2009) examined environmental consistency and faculty differences. The researchers examined 6,685 faculty responses to the 2003 Faculty Survey of Student Engagement. A 4 X 2 MANOVA data analysis identified that faculty within consistent environments generally demonstrated environmental
characteristics in line with Holland’s model for each environment, more so than faculty within inconsistent environments.

Holland’s theory has been used to better understand students and the academic environments they populate. Empirical research has shown the usefulness of Holland’s primary assumptions to categorize academic environments. Evidence also validates the usefulness of understanding the implications of Holland’s secondary assumptions of student selection of academic environments and environmental influences on students.

This literature review of academic environment models found noted differences among students and faculty within and among academic environments. Academic environment models, such as those developed by Holland (1966, 1973, 1985, 1997) and Biglan (1973a, 1973b), are currently used to categorize higher education populations for comparison and analysis. However, there is little research that examines the influence of academic environments on students, and student outcomes. To address this vacancy in research, Holland’s model of academic environments is used as a theoretical lens. Even with the increased use of Holland’s theory, the literature review found a lack of research exploring the validity of Holland’s Hexagonal Model or categorization of academic majors into environments.

Summary

A university education represents one ideal form of educating our youth; a form of education that benefits both the individual and society. To meet society’s demand for an educated populous, policy makers look for ways to better understand the higher education environment. To improve this one form of education, researchers look to understand the influence engagement practices have on creating a value added
educational environment that leads to positive student outcomes. However, engagement is a multi-dimensional concept. A common definition of student engagement, and knowledge of effective value added engagement practices, can assist institutions with improving student education. To increase student learning, institutions are looking to better define engagement and better measure engagement practices of enrolled students.

An assessment tool of students’ engagement related behavior is The College Student Report. Responses from this test may be measured on a number of scales, or across different theoretical models, including division according to Holland’s environments. Statistical analysis of students’ self-assessment test results, like The College Student Report, may reveal differences among academic environments. Engagement of students is measured by researchers on various levels. Some researchers examine engagement levels of all combined students attending a university or college. However, research studies that look at differences among academic environments may help identify differences among faculty, staff, and student engagement practices.

This literature review revealed a long standing research interest in academic environment differences. The review also found a call for research that examines the influence an academic environment has on students, and the differences among students within and among an academic environment. Holland’s model of academic environments is one method by which to study the differences among environments and the influence of academic environments on students. The importance of possessing knowledge of academic environmental differences is the potential that this knowledge of differences may be used to alter environmental practices in ways that will foster engagement encouraging practices among faculty and students. Engagement practices which may lead
to positive student outcomes will reinforce the goals society asks its institutions of higher education to provide.

Engagement is an area of growing interest among faculty, administrators, and policy makers. Researchers use various academic and environmental models to categorize students and faculty in order to measure aspects of engagement among groups. Use of Holland’s academic environment model is increasingly used to describe engagement related characteristics among academic groups. However, a gap in the literature exists concerning the current validity of Holland’s theory, as a tool to categorize majors into environments, and of the Hexagonal Model. This question of validity raises an issue concerning the usefulness of the Hexagonal Model to examine engagement behavior differences along the lines of the six Holland environments. This study begins to fill this gap in the literature by using a measure of engagement (The College Student Report) to evaluate the validity of Holland’s environmental model as a comparison tool.
CHAPTER 3

METHODS

A review of the literature found research that utilizes Holland’s primary and secondary assumptions of six personality and environment types to explore aspects of student learning levels (Choi Man, 1983; Martin & Bartol, 1986; Feldman et al, 1999; Pike, 2006a; Pike, 2006b; Smart, 2008). Student engagement, as it pertains to higher-order thinking skills, has not been examined across majors or academic environments using any existing framework or model. In addition, no studies examine the soundness of Holland’s primary assumption of the six academic environments, in relation to grouping majors into academic environments. To examine the soundness of Holland’s theory of academic environments, this study uses univariate, multivariate, and cluster analysis to compare academic majors and environments on one measure of student engagement, Higher-Order Thinking Skills.

This chapter presents the methods that were used to organize and analyze a portion of student engagement results gathered by the 2005 administration of The College Student Report. The College Student Report is given during the spring semester each year to first year and senior students attending four year colleges and universities. The test measures multiple aspects of students’ engagement levels. A portion of The College Student Report of 2005 is used for this study because it: a) can be used to investigate the research questions used for this study, and b) enjoys wide spread use within higher education assessment. As The College Student Report is a secondary data set, it is necessary to describe NSSE data collection techniques and survey instruments.
This methods chapter is divided into three sections. The first section describes existing instruments that measure student engagement. The second section examines the data collected by NSSE in 2005 and the particular sample used for this study. The final section of this chapter outlines the statistical analyses this study uses to examine the data and address the research questions.

**Instruments**

The instrument used to collect the student assessment data for this dissertation was The College Student Report, administered by NSSE. NSSE was launched with support from The Pew Charitable Trust and designed by a national team chaired by Peter Ewell of the National Center for Higher Education Management Systems (NCHEMS) and George Kuh of the Indiana University Center for Survey Research (IUCPR). Today, NSSE is jointly administered by IUCPR and NCHEMS (NSSE, 2009d).

The College Student Report was developed to assess student and institution engagement levels in response to the acknowledgement of the positive outcomes associated with increased student engagement levels. To measure the different areas of student engagement which institutions emphasize, NSSE uses a series of questions that ask students to evaluate institutional demands and characteristics. The survey developers formed questions that fall into three broad categories: institutional practices, student behaviors, and student perceptions of the quality of institutional and educational practices. Survey questions were shaped by three guiding principles: 1) do questions address engagement practices that research has shown to improve student outcomes; 2) will answers to the questions assist students in choosing an appropriate institution to attend; 3) are questions easily understood by a general audience? In addition to writing
questions that examine practices linked to positive student outcomes, The College Student Report was created to achieve several additional goals. The survey was designed to be useful to both public and private four year institutions as a measure of upper and lower classmen experiences, and be flexible to adaptation for individual institutions. Additionally, it was designed to be efficiently administered to a large number of institutions (NSSE, 2009d).

The College Student Report of 2005 has 85 engagement related questions addressing topics such as course work demands, study habits, and student and faculty interactions. NSSE also asks respondents an additional 15 personal demographic questions. Assessment scores for the survey are in a Likert-type format, with questions measured on 4, 5, and 7 point scales. One question measures students’ number of hours studied on a graduated 8 point scale, ranging from “0” hours to “More than 30.”

The five questions from The College Student Report of 2005 (NSSE, 2005e) used in this study address the following statement: During the current school year, how much has your coursework emphasized the following mental activities? (Assessments are on a 4 point Likert scale: 1 = Very Little, 2 = Some, 3 = Quite a Bit, 4 = Very Much.)

a. Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form.

b. Analyzing the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components.”

c. Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships.
d. Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions.

e. Applying theories or concepts to practical problems in new situations.

**Pike’s Scalelets**

NSSE placed 42 questions from the College Student Report into five benchmarks to assess the level of use of educationally effective practices by students and institutions. These benchmarks measure “activities that research studies show are linked to desired outcomes in college” (NSSE, 2005b). The five benchmarks are: Level of Academic Challenge, Active and Collaborative Learning, Student-Faculty Interaction, Enriching Educational Experiences, Supportive Campus Environments (NSSE, 2009b).

In addition to the five NSSE defined Benchmarks, Pike (2006b) created 12 scalelets, drawn out of the five benchmarks, as a means to measure more specific aspects of engagement. Benchmarks and scalelets are composed of survey questions grouped according to broad similarities among the questions. While the scalelets are grouped within the five benchmarks, Pike used 49 questions from The College Student Report to create his twelve scalelets instead of the 42 that comprise the Benchmarks. The scalelet used for this dissertation is the Higher-order Thinking Skills (HTS) scalelet, one of three scalelets along with Course Challenge and Writing that comprise the Level of Academic Challenge (LAC) benchmark. The HTS scalelet gauges student assessment of environmental demands on students’ higher order thinking skills with course content.

Two HTS scalelets are cited in the literature (Pike, 2006b; Nelson Laird, Shoup, & Kuh, 2005). The original scalelet created by Pike (2006b) is composed of five questions that
measure environmental demands on students’ memorization, analysis, synthesis, making judgments, and application of course content. The other scalelet is composed of the same questions, minus memorization.

A study by Pike (2006b) examined the validity of the NSSE scalelet scores. The HTS standardized regression coefficients for student learning gains were $r = 0.660$ and $\beta_2 = 0.230$ for General Education gains, $r = 0.262$ and $\beta_2 = 0.207$ for Practical Skills gains. This indicates a correlational link between HTS and the student outcomes associated with general education (analytical and writing skills) and practical skills (understanding and using information technology). $\rho^2 = 0.77$ of the HTS scalelet indicates dependable group means for respondents to the HTS scalelet. These empirical findings show that the HTS scalelet is a reasonable predictive measure of positive student outcomes, an indirect focus of this research, and thus a reasonable measure to use for this research.

The scalelet that excludes memorization is used for this study. Chapter 4 contains tests of reliability and a factor analysis of each scalelet using the sample of responses for this study to show that the four item scalelet is appropriate for answering the dissertation research questions.

**NSSE Data Sample**

The following section first describes NSSE survey procedures and the 2005 survey response totals. Second, the descriptive statistics of the data set purchased from IUCPR are outlined, as well as the additions to the data set for the purpose of achieving a suitable margin of error. Third, the rational to include only senior student responses for this analysis is detailed and followed by a description of the sample size of senior responses. Next, I offer the rational to exclude first year student responses, and the
reasons to select a limited number of academic majors for this study. This section concludes with the characteristics of the senior student groups used for this study.

**NSSE survey procedures.**

NSSE survey responses are gathered from institutions of higher education that pay IUCPR to assess their students. The 2005 NSSE survey was administered to students at 529 public and private colleges and universities in the US and Canada (NSSE, 2005a). NSSE survey respondents are college students who are designated by their institution as first year or senior students. Students attending these institutions were either mailed paper copies or emailed web access to surveys. Surveys were sent to students during the spring semester of 2005. All responses by students were voluntary. Surveys were either completed and mailed in or completed online. Four email requests, to complete the online survey, were sent to non-respondent students (NSSE, 2009a). Over 660,000 surveys were distributed during the spring of 2005. Approximately 245,000 students responded to this survey, representing students from 85 distinct academic majors. Response rates were 52 percent for first-year students and 48 percent for senior students (NSSE, 2009c).

**Data set drawn for the study.**

The 2005 NSSE data set used for this study was purchased from IUCPR during the summer of 2008. At the time of purchase, the 2005 survey results were the most recent survey data available from NSSE for public purchase. The agreement with IUCPR allows the data to be analyzed for academic purposes, including dissertation work, academic publications, or conference presentations. All test variables (survey item responses) from The College Student Report of 2005 were received from IUCPR.
The College Student Report of 2005 data set purchased from IUCPR is a random sample of only part of the entire 2005 group of students who took the test. The 2005 data set used for this survey is a 20% random sample (11,674 responses) of 53,628 first year and senior students enrolled in 25 majors designated for study. NSSE guidelines limit sample size available to independent researchers to a 20% random sample of selected data. The 25 majors included in the sample are: accounting, architecture, art, biology, chemistry, civil engineering, economics, education, electrical/electronic engineering, English, history, finance, pre-law, management, marketing, mathematics, mechanical engineering, medicine, music, philosophy, physics, nursing, political science, and psychology.

In order to create a survey sample size margin of error of 3.5%, with a 95% confidence level for all groups of majors, NSSE staff oversampled an additional 106 senior philosophy majors, 20 senior history majors, and 79 freshman philosophy majors to account for the lack of sufficient total numbers in an initial random sample of the purchased data sample. The total number of first year and senior student responses received from NSSE for this study is 11,674. This sample is composed of 35 percent male and 65 percent female respondents. Thirty six percent of this sample consists of freshman students, and 55 percent are seniors. The total number of senior responses received in this study sample is 6,481. Only these 6,481 senior responses will be used for this dissertation. The demographics of the senior group are essentially the same as the original data sample received from NSSE that contains both first-year and senior responses.
Rational for using senior data and select academic majors.

Senior students designating enrollment in only one major are analyzed in this study. This decision was made in line with Holland’s theory of person/environment fit. Senior students enrolled in a major, to near completion of the degree, signals compatibility with that one academic environment. In addition, seniors enrolled in only one academic major will theoretically give a more accurate reflection of the higher-order thinking skills demands within a single academic major. Students with two or more majors may be enrolled in majors grouped into incongruent environments. Survey results from students enrolled in multiple environments may be mixed. This presents a confounding variable with implications beyond the scope of this study.

Freshmen are excluded from analysis since they may express interest in an academic major possibly without understanding if their personality is compatible with that major. A freshman’s interest in a major may not reflect potential self-selection out of one major and into another, nor does it reflect potential environmental pressures on a student to either leave a particular major or change and conform to it. Freshmen are traditionally enrolled in a variety of courses that span multiple academic majors and/or environments. Freshman responses to The College Student Report may possibly be assessing the general climate of a multitude of academic majors or environments, thus assessing multiple major and/or environment demands instead of a single major and/or environment.

The 2005 survey contains characteristics of students enrolled in 85 academic majors. Even a basic analysis of this number of majors would quickly become unwieldy. As a way to narrow the focus of this study, and make comparisons somewhat
manageable, 13 liberal art majors and 12 professional majors were selected for the
purpose of this study. These 25 majors were chosen because of their traditional definition
as liberal arts and professional degrees (Stancil, 2003; Carnegie Foundation, 2009). This
liberal arts/professional degree designation is a way to include a representative selection
of majors offered at higher education institutions, which also aligns with all six of
Holland’s academic environment categories.

The 25 majors selected for this study are the 12 liberal arts majors of:
architecture, art, biology, chemistry, English, history, mathematics, music, philosophy,
physics, political science, psychology (Stancil, 2003). The 13 professional degrees in this
sample, defined as “Professional schools” by the Carnegie Foundation (2009), include:
accounting, civil engineering, economics, electrical/electronic engineering,
elementary/middle school education, finance, management, marketing, mechanical
engineering, medicine, nursing, pre-law, secondary education (Carnegie Foundation,
2009). Table 4 shows a summary of the student data sample used for this study, relative
to NSSE totals for students within the majors used in this study.

Table 4 breaks the total responses received from the NSSE survey into the 25
majors the data set represents. The Total Students column lists the total number of senior
and freshmen responses within each of the 25 majors, received from NSSE.
The Percentage column immediately to the right lists the percentages of senior and
freshman responses for each major. The Seniors column lists the total number of senior
respondents by majors for the 2005 survey. The far right Percentage column lists the
percentages of senior responses, by major.
Table 4

Student Majors, Total Numbers, and Percentage Totals for Study

<table>
<thead>
<tr>
<th>Major</th>
<th>Total Students</th>
<th>Percentage</th>
<th>Seniors</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td>608</td>
<td>5%</td>
<td>348</td>
<td>5%</td>
</tr>
<tr>
<td>English</td>
<td>686</td>
<td>6%</td>
<td>418</td>
<td>6%</td>
</tr>
<tr>
<td>History</td>
<td>489</td>
<td>4%</td>
<td>310</td>
<td>5%</td>
</tr>
<tr>
<td>Music</td>
<td>302</td>
<td>3%</td>
<td>142</td>
<td>2%</td>
</tr>
<tr>
<td>Philosophy</td>
<td>273</td>
<td>2%</td>
<td>161</td>
<td>2%</td>
</tr>
<tr>
<td>Biology</td>
<td>1064</td>
<td>9%</td>
<td>536</td>
<td>8%</td>
</tr>
<tr>
<td>Accounting</td>
<td>623</td>
<td>5%</td>
<td>386</td>
<td>6%</td>
</tr>
<tr>
<td>Finance</td>
<td>301</td>
<td>3%</td>
<td>221</td>
<td>3%</td>
</tr>
<tr>
<td>Marketing</td>
<td>448</td>
<td>4%</td>
<td>284</td>
<td>4%</td>
</tr>
<tr>
<td>Management</td>
<td>575</td>
<td>5%</td>
<td>349</td>
<td>5%</td>
</tr>
<tr>
<td>Elementary Education</td>
<td>994</td>
<td>9%</td>
<td>554</td>
<td>9%</td>
</tr>
<tr>
<td>Secondary Education</td>
<td>206</td>
<td>2%</td>
<td>97</td>
<td>2%</td>
</tr>
<tr>
<td>Civil Engineering</td>
<td>198</td>
<td>2%</td>
<td>111</td>
<td>2%</td>
</tr>
<tr>
<td>Electrical Engineering</td>
<td>234</td>
<td>2%</td>
<td>135</td>
<td>2%</td>
</tr>
<tr>
<td>Mechanical Engineering</td>
<td>362</td>
<td>3%</td>
<td>166</td>
<td>3%</td>
</tr>
<tr>
<td>Chemistry</td>
<td>262</td>
<td>2%</td>
<td>133</td>
<td>2%</td>
</tr>
<tr>
<td>Math</td>
<td>241</td>
<td>2%</td>
<td>145</td>
<td>2%</td>
</tr>
<tr>
<td>Physics</td>
<td>113</td>
<td>1%</td>
<td>66</td>
<td>1%</td>
</tr>
<tr>
<td>Architecture</td>
<td>149</td>
<td>1%</td>
<td>75</td>
<td>1%</td>
</tr>
<tr>
<td>Law</td>
<td>64</td>
<td>&gt;1%</td>
<td>25</td>
<td>&gt;1%</td>
</tr>
<tr>
<td>Medicine</td>
<td>147</td>
<td>1%</td>
<td>41</td>
<td>&gt;1%</td>
</tr>
<tr>
<td>Nursing</td>
<td>1065</td>
<td>9%</td>
<td>424</td>
<td>7%</td>
</tr>
<tr>
<td>Economics</td>
<td>233</td>
<td>2%</td>
<td>150</td>
<td>2%</td>
</tr>
<tr>
<td>Political Science</td>
<td>673</td>
<td>6%</td>
<td>388</td>
<td>6%</td>
</tr>
<tr>
<td>Psychology</td>
<td>1364</td>
<td>12%</td>
<td>816</td>
<td>13%</td>
</tr>
<tr>
<td>Total Students:</td>
<td>11674</td>
<td>101%</td>
<td>6481</td>
<td>100%</td>
</tr>
</tbody>
</table>

The Research Questions

The following section describes the research questions, theoretical framework, and the statistical methods that direct this study. The first section lists the three questions. The second section describes how the data will be organized according to Holland’s theory. The third section describes the statistical analyses used to answer the research questions.
The three research questions shown in Chapter 1 are repeated here:

1. Are there environmental engagement demand differences among the six Holland academic environments on Pike’s HTS scalelet?

2. Are there environmental engagement demand differences among the six Holland academic environments on any of five individual items associated with Pike’s HTS scalelet?

3. How do 25 academic majors group according to the HTS Scalelet?

**Data Organization According to Holland’s Model**

Student assessment scores of environmental engagement demands as measured by the HTS scalelet were analyzed for students enrolled in the academic majors that comprise each of the six Holland environments. This study separated the 25 selected majors shown in Table 4 into the Holland model of academic environments, as outlined in *The Educational Opportunities Finder* (Rosen et al, 1997). Table 5 below shows the specific categorization of majors and their associated environments, as used in this study.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Academic Major</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realistic</td>
<td>Electrical Engineering, Mechanical Engineering</td>
</tr>
<tr>
<td>Investigative</td>
<td>Biology, finance, chemistry, civil engineering, mathematics, physics, medicine, economics</td>
</tr>
<tr>
<td>Artistic</td>
<td>Art, English, music, architecture</td>
</tr>
<tr>
<td>Social</td>
<td>Philosophy, political science, psychology, elementary education, secondary education, nursing</td>
</tr>
<tr>
<td>Enterprising</td>
<td>Marketing, management, law, history</td>
</tr>
<tr>
<td>Conventional</td>
<td>Accounting</td>
</tr>
</tbody>
</table>

(Rosen et al, 1997)
Data of the 25 academic majors were drawn from the sample supplied by NSSE. Senior responses from the 25 majors will be divided into the six Holland environments as shown in Table 5. The number of responses used in this study, for each environment, is as follows: realistic environment, 314 respondents; investigative environment, 1,326 respondents; artistic environment, 969 respondents; social environment, 2,445 respondents; enterprising environment, 950 respondents; and conventional environment, 392 respondents.

**Analyses to Answer the Research Questions**

The three questions examine differences in higher-order thinking skills across different majors and academic environments, as specified by Holland. The questions also present the opportunity to evaluate the validity of Holland’s model by 1) examining predicted engagement similarities or differences among the six Holland academic environments, and 2) hypothesizing the placement of academic majors into academic environments based on the analysis and comparing that to the predicted placement according to Holland’s model.

Environmental demands on students’ higher-order thinking skills were measured two ways. Scores from the HTS scalelet were analyzed using a one-way ANOVA and a cluster analysis. The five questions associated with the HTS were also analyzed individually using a one-way MANOVA. For the purpose of this study, students’ NSSE survey results act as a proxy of students’ assessments of the engagement demands of the six Holland academic environments. The three research questions, and mode of analysis to examine each question, are outlined in Table 6.
**Table 6**

*Dissertation Research Questions*

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Statistical Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are there environmental engagement demand differences among the six Holland academic environments on Pike’s HTS scalelet?</td>
<td>One-Way ANOVA</td>
</tr>
<tr>
<td>2. Are there environmental engagement demand differences among the six Holland academic environments on any of five individual items associated with Pike’s HTS scalelet?</td>
<td>One-Way MANOVA</td>
</tr>
<tr>
<td>3. How do 25 academic majors group according to the HTS scalelet?</td>
<td>Cluster Analysis</td>
</tr>
</tbody>
</table>

ANOVA, MANOVA, and cluster analysis were used to evaluate Holland’s model, as measured by higher-order thinking skills. ANOVA and MANOVA environmental comparisons of adjacent and opposite environments on Holland’s Hexagonal model may validate or raise questions of the model. The analysis is limited to a comparison of opposite and adjacent environments to reasonably delimit the study; and, indeed, Holland’s model groups the six environments around a circular hexagonal model, with similar environments next to each other and increasingly dissimilar environments more distant from each other. It seems reasonable, then, as a starting point, to compare those environments that are next to each other on the model (adjacent) and those that are farthest apart (opposite), on some common measure such as the HTS.

The cluster analysis groups the various academic majors according to student responses to demands on their higher-order thinking skills. The results of this analysis were then compared with Holland’s model of grouping academic majors into six
academic environments. This final analysis may raise questions of the appropriateness of the placement of academic majors within environments according to Holland’s theoretical placements. Cluster analysis findings could point to the need to re-categorized academic majors into environments with more consistent demands on students.

A review of the literature revealed no studies that examined the basic tenants of Holland’s Hexagonal Model arrangement of academic environments. The veracity of his model, as it applies to placing majors within academic environments, has not been tested. The ANOVA and MANOVA were selected to analyze the data because these methods offer basic descriptive statistics on majors grouped among Holland environments. The cluster analysis will group academic majors based on similarities. A cluster grouping of these 25 majors will demonstrate whether or not these majors group according to Holland’s theory of academic environments. This study will advance the understanding of Holland’s theory and potentially benefit students and faculty by expanding our understanding of environmental differences.
CHAPTER 4

RESULTS

This chapter presents the empirical analyses used to evaluate the research questions of this dissertation. First, descriptive statistics are reported. Second, reliability and factor analyses conducted by the author are included. These analyses were run in order to determine which HTS scalelet to use for this research. Third, univariate and multivariate analysis results for environmental comparisons of the HTS scalelet and each of the five questions are outlined. The final section presents the cluster analysis results of the 25 majors categorized into homogeneous environmental groupings. All statistical analysis was performed on PASW Version 17 (2009).

Descriptive Statistics

Responses from 6,481 cases were used in this research. Research questions One and Three use all 6,481 responses in the analysis. Question Two used 6,473 cases for analysis; eight cases are excluded due to lack of individual survey responses. Academic environment number totals are listed in Tables 7 and 8. Total numbers for individual academic majors are listed in Table 4, of Chapter Three.

Table 7

<table>
<thead>
<tr>
<th>Question One and Three Environmental Ns</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holland Environment</td>
<td></td>
</tr>
<tr>
<td>1: Realistic</td>
<td>301</td>
</tr>
<tr>
<td>2: Investigative</td>
<td>1,403</td>
</tr>
<tr>
<td>3: Artistic</td>
<td>983</td>
</tr>
<tr>
<td>4: Social</td>
<td>2,439</td>
</tr>
<tr>
<td>5: Enterprising</td>
<td>969</td>
</tr>
<tr>
<td>6: Conventional</td>
<td>386</td>
</tr>
<tr>
<td>Total</td>
<td>6,481</td>
</tr>
</tbody>
</table>
Table 8

*Table 8 Question Two Environmental N’s*

<table>
<thead>
<tr>
<th>Holland Environment</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Realistic</td>
<td>301</td>
</tr>
<tr>
<td>2: Investigative</td>
<td>1,400</td>
</tr>
<tr>
<td>3: Artistic</td>
<td>981</td>
</tr>
<tr>
<td>4: Social</td>
<td>2,438</td>
</tr>
<tr>
<td>5: Enterprising</td>
<td>968</td>
</tr>
<tr>
<td>6: Conventional</td>
<td>385</td>
</tr>
<tr>
<td>Total</td>
<td>6,473</td>
</tr>
</tbody>
</table>

**Preliminary Analyses of Scalelet Questions**

Questions One and Three of this research use an HTS scalelet, as created by Pike (2006b), to measure differences between academic environments and academic majors. However, two versions of this scalelet have emerged in recent literature (Pike, 2006b; Nelson Laird, Shoup, & Kuh, 2005): One version contains five questions encompassing all five higher-order thinking skills while a second version omits one of the thinking skills (memorization). To determine the most uniform HTS scalelet version to use for this research, the five NSSE Higher-order Thinking Skills questions (Memorizing, Analyzing, Synthesizing, Making Judgments, and Applying) were subjected to reliability and principle components analyses. These analyses provide insight into the relationship among the questions, given the survey responses used for the dissertation reliability analysis examines if questions measure the same concept. Principle components analysis reduces multiple variables and determines whether variables hold together. For example, if Memorization does not measure the same construct as Analyzing, Synthesizing, Making Judgments, or Applying, the reliability and principle components analysis results should yield appropriate indicators that this is the case, given the data. These tests offer
insight into which HTS scalelet is most appropriate for this study.

**Reliability Analysis**

Reliability tests were run on this study’s NSSE data set to determine the degree to which the five HTS questions measure the same concept. Cronbach’s $\alpha = .657$ of the five questions measured together. The alpha coefficient for the five questions is slightly below the minimally accepted 0.7 threshold for acceptance as a coherent concept (Nunnaly & Bernstein, 1994). While there is debate regarding this threshold level, this analysis suggests that the five Higher-order Thinking Skills questions do not form a reliable concept.

If Memorizing is removed from the group of five questions, $\alpha = 0.815$. However, if any of the other four questions are removed from the set the alpha levels drop below the acceptable 0.7 level. If the Analyzing question is removed from the data set, $\alpha = 0.553$. With the Synthesizing question removed $\alpha = 0.492$. If the Making Judgments question removed, $\alpha = 0.527$. If the Applying question is removed, $\alpha = 0.541$. Such low $\alpha$ levels mean grouping Memorizing with any three of the other four questions creates an unreliable measure of higher-order thinking skills. If Memorizing is removed from the group of five questions, Cronbach’s $\alpha = .815$. Removing memorization from the group of questions creates a more reliable measure of higher-order thinking skills. An alpha of .815 of these four questions suggests that the four questions, minus Memorizing, forms a coherent concept.

The final reliability analysis examined results for only the four questions of Analyzing, Synthesizing, Making Judgments, and Applying. If any one of the four questions is omitted, the reliability statistic drops below the group alpha level of .815, but
still above the 0.7 threshold. If the Analyzing question is removed, $\alpha = 0.772$. If the Synthesizing question is removed, $\alpha = 0.740$. If the Making Judgments questions is removed, $\alpha = 0.772$. If the Applying question is removed, $\alpha = 0.784$. While any grouping of three of the four questions has acceptable reliability alpha levels the four questions together strengthen the reliability of the measure. The reliability analysis suggests that the Analyzing, Synthesizing, Making Judgments, and Applying questions create a coherent concept. These findings suggest the HTS scalelet that omits Memorizing is the most reliable homogeneous concept to use for this study.

**Principle Components**

Findings from a principle components analysis of the five questions aligned with the reliability analysis. The Memorizing question forms one factor, while the four questions concerning Analyzing, Synthesizing, Making Judgments, and Applying forms another factor (See Table 9).

<table>
<thead>
<tr>
<th></th>
<th>Component 1</th>
<th>Component 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memorizing</td>
<td>-0.099</td>
<td>0.992</td>
</tr>
<tr>
<td>Analyzing</td>
<td>0.801</td>
<td>-0.076</td>
</tr>
<tr>
<td>Synthesizing</td>
<td>0.84</td>
<td>0.093</td>
</tr>
<tr>
<td>Making Judgments</td>
<td>0.796</td>
<td>0.04</td>
</tr>
<tr>
<td>Applying</td>
<td>0.772</td>
<td>0.064</td>
</tr>
</tbody>
</table>

The principle component analysis implies that Memorizing forms its own concept, separate from the other four questions. This finding is in line with the reliability analysis.

Table 10 illustrates the standard output associated with a principle components
Table 10

Principle Components Output for HTS Questions

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squares Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>1</td>
<td>2.586</td>
<td>51.721</td>
</tr>
<tr>
<td>2</td>
<td>1.003</td>
<td>20.065</td>
</tr>
<tr>
<td>3</td>
<td>0.541</td>
<td>10.814</td>
</tr>
<tr>
<td>4</td>
<td>0.495</td>
<td>9.894</td>
</tr>
<tr>
<td>5</td>
<td>0.375</td>
<td>7.506</td>
</tr>
</tbody>
</table>
analysis. This output shows Component 1, containing the four questions of Applying, Analyzing, Synthesizing, and Making Judgments, accounts for over 50% of the variance and has an Eigen value over two and a half times larger than the second component. Component 2 contains the Memorizing question and is its own component. It does not group with the other four questions.

Examining the internal consistency and running principle component analyses indicate that Memorizing is a separate and distinct concept from the other four questions used in this study. The goal of this research is to measure one coherent concept of higher-order thinking. For this reason, the HTS scalelet that omits Memorizing will be used for Questions One and Three. However, the Memorizing question will be used in analysis of Question Two, since each question is measured independently. The Memorizing question is included in the analysis of Question Two because, as an arguably separate concept, as evident from the reliability and principle component analyses, it will add another measure for consideration within the context of Holland’s model.

**Research Questions and Statistical Analysis**

Questions One and Two compare adjacent and opposite environments, as described in Holland’s Hexagonal model. The reasons for choosing only these comparisons, as explained in Chapter Three, are grounded in Holland’s model and theory of consistency. Adjacent environments, those closest to each other on the model and theoretically the most similar (or consistent), should demonstrate little statistical difference from each other. Opposite (or inconsistent) environments, environments furthest from each other on the hexagonal model and theoretically the most dissimilar to each other, are more likely than adjacent environments to have statistically significant
differences.

For this study, academic environments are given a number for ease of deciphering the statistical analyses. Academic environments are numbered clockwise, according the hexagonal model. The Realistic environment is 1, Investigative is 2, Artistic is 3, Social is 4, Enterprising is 5, and Conventional is 6.

**Research Question One**

Research Question One: Are there environmental engagement demand differences among the six Holland academic environments on Pike’s HTS scalelet?

To answer question one, NSSE data were analyzed using a one-way ANOVA. Statistical significance level is set at an alpha level of .05. A significant effect among academic environments was found on the HTS scalelet, $F (1, 5) = 14.390, p < .0005$, partial $\eta^2 = .011$. Descriptive statistics of Question One are reported in Table 11.

Tukey post hoc analysis p value results for adjacent and opposite environments, with the Bonferroni correction, are outlined in Tables 12 and 13. Table 12 shows only the p values of adjacent environments. Three of the environments are statistically different, while three are not. Three of the adjacent environments are not compatible with Holland’s model, while three are compatible with Holland’s model.

With Table 12 comparisons in mind, note that Holland’s (1997) model predicts a general level of increasing difference among environments the further environments are from each other on the hexagonal model. Therefore, one might expect that opposite environments will have statistically significant differences. Table 13 lists p values of opposite environments.
Table 11

*Question One Descriptive Statistics*

<table>
<thead>
<tr>
<th>Environment</th>
<th>HTS Scalelet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Realistic (1)</td>
<td>72.3976</td>
</tr>
<tr>
<td>(n = 301)</td>
<td></td>
</tr>
<tr>
<td>Investigative (2)</td>
<td>70.6066</td>
</tr>
<tr>
<td>(n = 1403)</td>
<td></td>
</tr>
<tr>
<td>Artistic (3)</td>
<td>68.0428</td>
</tr>
<tr>
<td>(n = 983)</td>
<td></td>
</tr>
<tr>
<td>Social (4)</td>
<td>73.6812</td>
</tr>
<tr>
<td>(n = 2439)</td>
<td></td>
</tr>
<tr>
<td>Enterprising (5)</td>
<td>70.1439</td>
</tr>
<tr>
<td>(n = 969)</td>
<td></td>
</tr>
<tr>
<td>Conventional (6)</td>
<td>67.0121</td>
</tr>
<tr>
<td>(n = 386)</td>
<td></td>
</tr>
</tbody>
</table>

One observation is that in Table 13 there are no statistical differences between the three opposite environments. In fact, the p values suggest that the three opposite environments are essentially the same, with regards to the HTS scalelet. The findings of opposite environments (showing no statistical difference) are not in line with Holland’s model. Holland’s (1997) model predicts increasing differences as environments are further away from each on the Hexagonal model.

Table 14 shows the ratio of unexpected to expected findings, which essentially summarizes the analysis from Table 12 and 13.

Question One analysis reveals half of the adjacent environments are in line with Holland’s model and half are not; while all of the opposite environments are incongruent
Table 12

*Question One P Values Between Adjacent Environments*

<table>
<thead>
<tr>
<th>Question</th>
<th>Realistic(1)</th>
<th>Investigative(2)</th>
<th>Artistic(3)</th>
<th>Social(4)</th>
<th>Enterprising(5)</th>
<th>Conventional(6)</th>
<th>Realistic(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTS Scalelet</td>
<td>0.782</td>
<td>0.050</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>0.153</td>
<td>0.015</td>
<td></td>
</tr>
</tbody>
</table>

Table 13

*Question One P Values Between Opposite Environments*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Realistic(1)</th>
<th>Social(4)</th>
<th>Investigative(2)</th>
<th>Enterprising(5)</th>
<th>Artistic(3)</th>
<th>Conventional(6)</th>
<th>Realistic(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTS Scalelet</td>
<td>0.927</td>
<td>0.966</td>
<td>0.966</td>
<td>0.969</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14

*HTS Scalelet Expected-to-Unexpected Outcome Summary*

<table>
<thead>
<tr>
<th>Total occurrences</th>
<th>Measure</th>
<th>Expected # of adjacent environments showing statistical difference</th>
<th>Unexpected # of adjacent environments showing no statistical differences</th>
<th>Expected # of opposite environments showing statistical difference</th>
<th>Unexpected # of opposite environments showing no statistical differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:7</td>
<td>HTS Scalelet</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
with Holland’s theory. Seven out of nine of the comparisons are not expected findings, while two are expected relative to Holland’s model.

**Research Question Two**

Research Question Two: Are there environmental engagement demand differences among the six Holland academic environments on any of five individual items associated with Pike’s HTS scalelet?

The one-way MANOVA compared opposite and adjacent environment by the five individual HTS questions. With use of the Wilks’ λ criterion, the analysis reveals statistically significant differences among environments, $F(5, 25) = 22.596$, $p < .0005$, partial $\eta^2 = .017$. The univariate analyses of the five HTS questions were followed-up using the Tukey-HSD procedure ($p=.05$) with the Bonferroni correction. Results of the univariate analyses for the main effect of the Memorizing question are $F(1,5) = 33.685$, $p < .001$. Results for the Analyzing question are $F(1,5) = 8.026$, $p < .001$. Results for the Synthesizing question are $F(1,5) = 16.303$, $p < .0001$. Results for the Making Judgments question are $F(1,5) = 20.437$, $p < .0001$. Results for the Applying question are $F(1,5) = 22.055$, $p < .0001$.

Means and Standard Deviations for the environments, by questions, are listed in Table 15.

Analysis results reveal findings similar to Question One findings. Tests of between-subject effects reveal statistical significance and non-significance between environments on all five HTS questions. Statistical significance and non-significance was found among adjacent environments, some findings are incongruent with Holland’s
<table>
<thead>
<tr>
<th>Environments</th>
<th>Memorizing</th>
<th>Analyzing</th>
<th>Synthesizing</th>
<th>Making Judgments</th>
<th>Applying</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Realistic (1)</td>
<td>2.47</td>
<td>0.93</td>
<td>3.43</td>
<td>0.697</td>
<td>2.98</td>
</tr>
<tr>
<td>(n = 301)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investigative (2)</td>
<td>2.86</td>
<td>0.9</td>
<td>3.27</td>
<td>0.706</td>
<td>3.07</td>
</tr>
<tr>
<td>(n = 1400)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artistic (3)</td>
<td>2.4</td>
<td>0.96</td>
<td>3.18</td>
<td>0.812</td>
<td>3.08</td>
</tr>
<tr>
<td>(n = 981)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social (4)</td>
<td>2.67</td>
<td>0.92</td>
<td>3.29</td>
<td>0.726</td>
<td>3.170</td>
</tr>
<tr>
<td>(n = 2438)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterprising (5)</td>
<td>2.75</td>
<td>0.85</td>
<td>3.280</td>
<td>0.718</td>
<td>2.99</td>
</tr>
<tr>
<td>(n = 968)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conventional (6)</td>
<td>2.750</td>
<td>0.852</td>
<td>3.16</td>
<td>0.731</td>
<td>2.82</td>
</tr>
<tr>
<td>(n = 385)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
model. Statistical significance and non-significance was also found among opposite environments, again, some findings are out of line with Holland’s model. Statistical significance was set at a confidence level of .05. The F statistic for adjacent and opposite environments are listed in Tables 16 and 17.

**Comparisons of Adjacent and Opposite Environments**

**Memorizing.**

Post-hoc analysis of the Memorizing question reveals statistical significance among the six environments, $F (1, 5) = 33.685$, $p < .0005$, partial $\eta^2 = .025$. Based upon the statistical significant among adjacent environments and between opposite environments, one would expect less significant differences among adjacent environments, while opposite environments would tend to have more statistically significant differences.

Review of the Memorizing question reveals statistically significant differences between four of the six adjacent environments: Realistic(1) and Investigative(2), Investigative(2) and Artistic(3), Artistic(3) and Social(4), and Realistic(1) and Conventional(6). No statistically significant difference was found between one set of opposite environments: Investigative (2) and Enterprising (5).

**Analyzing.**

Post-hoc analysis of the Analyzing question reveals statistical significance among the six environments, $F (1, 5) = 8.026$, $p<.0005$, partial $\eta^2 = .006$. Review of the Analyzing question data reveals statistically significant differences between four adjacent environments: Realistic(1) and Investigative(2), Investigative(2) and Artistic(3), Artistic(3) and Social(4), and Realistic(1) and Conventional(6).
Table 16

**Question Two P Values Between Adjacent Environments**

<table>
<thead>
<tr>
<th>Question</th>
<th>Realistic(1)</th>
<th>Investigative(2)</th>
<th>Artistic(3)</th>
<th>Social(4)</th>
<th>Enterprising(5)</th>
<th>Conventional(6)</th>
<th>Realistic(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memorizing</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>0.314</td>
<td>1.000</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Analyzing</td>
<td>&lt;.009</td>
<td>0.046</td>
<td>0.001</td>
<td>1.000</td>
<td>0.103</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Synthesizing</td>
<td>1.000</td>
<td>1.000</td>
<td>0.090</td>
<td>&lt;.0001</td>
<td>0.010</td>
<td>0.192</td>
<td></td>
</tr>
<tr>
<td>Making Judgments</td>
<td>1.000</td>
<td>1.000</td>
<td>&lt;.0001</td>
<td>1.000</td>
<td>0.028</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Applying</td>
<td>0.001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td>1.000</td>
<td>&lt;.0001</td>
<td></td>
</tr>
</tbody>
</table>

Table 17

**Question Two P Values Between Opposite Environments**

<table>
<thead>
<tr>
<th>Question</th>
<th>Realistic(1)</th>
<th>Social(4)</th>
<th>Investigative(2)</th>
<th>Enterprising (5)</th>
<th>Artistic(3)</th>
<th>Conventional (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memorizing</td>
<td>0.005</td>
<td>0.096</td>
<td></td>
<td></td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Analyzing</td>
<td>0.036</td>
<td>1.000</td>
<td></td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Synthesizing</td>
<td>0.003</td>
<td>0.402</td>
<td></td>
<td></td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Making Judgments</td>
<td>&lt;.0001</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Applying</td>
<td>0.008</td>
<td>&lt;.0001</td>
<td></td>
<td></td>
<td>0.218</td>
<td></td>
</tr>
<tr>
<td>Total occurrences Expected: Unexpected</td>
<td>Measure</td>
<td>Expected # of adjacent environments showing statistical difference</td>
<td>Unexpected # of adjacent environments showing no statistical differences</td>
<td>Expected # of opposite environments showing statistical difference</td>
<td>Unexpected # of opposite environments showing no statistical differences</td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-----------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>4:5</td>
<td>Memorizing</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3:6</td>
<td>Analyzing</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>6:3</td>
<td>Synthesizing</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>6:3</td>
<td>Making Judgments</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3:6</td>
<td>Applying</td>
<td>1</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
Artistic(3) and Social(4), and Realistic(1) and Conventional(6). No statistically significant difference was found between two opposite environments: Investigative (2) and Enterprising (5), and Artistic (3) and Conventional (6).

**Synthesizing.**

Post-hoc analysis of the Synthesizing question reveals statistical significance among the six environments, $F (1, 5) = 16.303$, $p < .0005$, partial $\eta^2 = .012$. Analysis of the Synthesizing question reveals statistically significant differences between only two of the six adjacent environments: Enterprising (5) and Social (4), and Enterprising (5) and Conventional (6). No statistically significant difference was found between only one set of opposite environments: Investigative (2) and Enterprising (5).

**Making Judgments.**

Post-hoc analysis of the Making Judgments question reveals statistical significance among the six environments, $F (1, 5) = 20.437$, $p < .0005$, partial $\eta^2 = .016$. Analysis of the Making Judgments question reveals statistically significant differences between only two of the six adjacent environments: Artistic (3) and Social (4), and Enterprising (5) and Conventional (6). No statistically significant difference was found between only one set of opposite environments: Artistic (3) and Conventional (6).

**Applying.**

Post-hoc analysis of the Applying question reveals statistical significance among the six environments, $F (1, 5) = 22.055$, $p < .0005$, partial $\eta^2 = .017$. Analysis of the Applying question reveals statistically significance differences between five of the six adjacent environments: Realistic(1) and Investigative(2), Investigative(2) and Artistic(3), Artistic(3) and Social(4), Social(4) and Enterprising(5), and Realistic(1) and
Conventional(6). No statistically significant difference was found between one set of opposite environments: Artistic (3) and Conventional (6).

In conclusion, findings from Questions One and Two revealed unexpected and excepted findings in accordance with Holland’s model. For Research Question One, seven of the comparisons where unexpected while two were expected (see Table 18). Slightly more than half (23 of 45) of the comparison findings in Research Question Two, only 22 out of 45, are expected. Twenty-three of the findings are not in line with expected Holland findings. Table 18 groups all of Research Question Two’s totals and ratio of expected to unexpected findings into one table. Interpretations of these results are in Chapter 5.

**Research Question Three**

Research Question Three: How do 25 academic majors group according to the HTS Scalelet?

Cluster analysis was used to answer Research Question Three, to identify potential groupings of academic majors according to the HTS scalelet. Twenty five academic majors were grouped into 6 clusters, as a means to evaluate Holland’s (1997) groupings of majors into six academic environments. The specific clustering technique to analyze the data is Squared-Euclidian distance. Table 19 displays the descriptive statistics of each academic major. Descriptive statistics list the mean scores for each major, which cluster analysis uses to group majors.

Cluster analysis of these 25 majors may reveal if majors group according to Holland’s model of academic environments. Table 20 lists cluster groupings of the academic majors. Also listed in Table 20 are the group means for each cluster. This mean
represents the average for all cases that fell into a particular cluster.

Cluster analysis results reveal seven academic majors grouped in Cluster 1, five majors into Cluster 2, nine majors into Cluster 3, two majors into Cluster 4, one major into Cluster 5, and one major into Cluster 6.

Table 21 lists the cluster groupings that are in Table 20. However, Table 21 adds next to each academic major a number in parentheses. This number represents the academic environment to which each major belongs, according to Holland’s (1997) model and the numbering scheme used throughout this analysis.

Table 22 is identical to Table 21 but without the academic major descriptions. Table 36 is meant to be a simplified view of the clustering results by showing only the academic environment to which each of the majors belong.

Table 22 shows the mixed nature of the cluster groupings. Cluster 1 is comprised of majors from five environments. Cluster 2 has majors in it from four environments. Cluster 3 is also made up of majors from four environments. Cluster 4 is comprised of majors from only one environment. Clusters 5 and 6 each only have one major, from the same academic environment, placed into them.

Group clusters outlined in Tables 21 and 22 offer mixed results concerning majors’ theorized placement into Holland academic environments. Majors that comprise each of the academic environments were divided up and placed into clusters in a way that is, for the most part, inconsistent with Holland’s grouping of academic majors into environments.
### Table 19

**NSSE Coded Majors Descriptive Statistics**

<table>
<thead>
<tr>
<th>Major</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Art</td>
<td>348</td>
<td>63.9687</td>
<td>23.46514</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>2: English</td>
<td>418</td>
<td>72.3684</td>
<td>22.08308</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>3: History</td>
<td>310</td>
<td>72.5090</td>
<td>22.52064</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>6: Music</td>
<td>142</td>
<td>63.4977</td>
<td>24.10192</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>7: Philosophy</td>
<td>161</td>
<td>78.5197</td>
<td>20.88826</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>12: Biology</td>
<td>536</td>
<td>71.2272</td>
<td>21.04872</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>20: Accounting</td>
<td>386</td>
<td>67.0121</td>
<td>22.56679</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>22: Finance</td>
<td>221</td>
<td>66.7421</td>
<td>21.51155</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>24: Marketing</td>
<td>284</td>
<td>70.3638</td>
<td>20.71135</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>25: Management</td>
<td>349</td>
<td>67.4546</td>
<td>21.28289</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>28: Elementary Ed.</td>
<td>554</td>
<td>69.3291</td>
<td>21.13910</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>31: Secondary Ed.</td>
<td>97</td>
<td>67.6117</td>
<td>22.01103</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>35: Civil Eng.</td>
<td>111</td>
<td>73.2733</td>
<td>21.61758</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>37: Electrical Eng.</td>
<td>135</td>
<td>70.8025</td>
<td>21.73721</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>40: Mechanical Eng.</td>
<td>166</td>
<td>73.6948</td>
<td>20.01607</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>44: Chemistry</td>
<td>133</td>
<td>73.2456</td>
<td>20.79675</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>46: Mathematics</td>
<td>145</td>
<td>67.7586</td>
<td>19.45077</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>47: Physics</td>
<td>66</td>
<td>72.9798</td>
<td>20.09915</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>50: Architecture</td>
<td>75</td>
<td>71.4444</td>
<td>20.04936</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>53: Law</td>
<td>25</td>
<td>76.0000</td>
<td>20.02891</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>55: Medicine</td>
<td>41</td>
<td>73.7805</td>
<td>22.94021</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>58: Nursing</td>
<td>424</td>
<td>81.7610</td>
<td>18.97398</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>64: Economics</td>
<td>150</td>
<td>70.6111</td>
<td>20.90194</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>67: Political Sci.</td>
<td>388</td>
<td>74.3557</td>
<td>19.78604</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
<tr>
<td>68: Psychology</td>
<td>816</td>
<td>71.8750</td>
<td>21.74488</td>
<td>24</td>
<td>4676.515</td>
<td>10.256</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Total 6481
Table 20

Cluster Analysis Groupings of Majors

<table>
<thead>
<tr>
<th>Cluster Grouping</th>
<th align="right">1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Eng., Biology, Econ., Architecture, Elem. Ed., Psychology, Marketing</td>
<td align="right">70.807</td>
<td>67.315</td>
<td>73.578</td>
<td>63.733</td>
<td>78.519</td>
<td>81.761</td>
</tr>
<tr>
<td>History, Civil Eng., Mechanical Eng., Chemistry, English, Physics, Law, Medicine, Poli.Sci</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Art, Music</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philosophy</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nursing</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster Grouping</td>
<td align="right">1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>------------------</td>
<td align="right">---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Academic majors</td>
<td align="right">History(2), Civil Eng.(2), Mechanical Eng.(2), Chemistry(2), English(3), Electric Eng(1), Biology(2), Econ(2), Finance(2), Architecture(3), Elem. Ed.(4), Psychology(4), Marketing(5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grouped into Clusters.</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Environment # in ()</td>
<td align="right"></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 22

Cluster Analysis Groupings of Majors' Environment Number

<table>
<thead>
<tr>
<th>Cluster Grouping</th>
<th>1, 2, 3, 4, 4, 5</th>
<th>2, 2, 4, 5, 6</th>
<th>2, 2, 2, 3, 3, 4, 5, 5, 3, 3, 4, 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each Major's Academic Environment that Constitute Each Cluster</td>
<td>1, 2, 3, 4, 4, 5</td>
<td>2, 2, 4, 5, 6</td>
<td>2, 2, 2, 3, 3, 4, 5, 5, 3, 3, 4, 4</td>
</tr>
</tbody>
</table>

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Summary

This chapter detailed the analysis results of three research questions that examine the relationships among Holland’s academic environments. For Question One, an ANOVA was used to examine the relationship among the six environments according to an HTS Scalelet. For Question Two, a MANOVA examined similarities and differences of environmental engagement demands by using five questions associated with the HTS Scalelet. For Question Three, a cluster analysis was used to group 25 academic majors according to an HTS Scalelet, and then compared the resulting clusters with Holland’s placement of these 25 majors into environments.

The study found mixed results of environment similarities and differences, as viewed through Holland’s (1997) model. The ANOVA for Question One found three adjacent environments with no statistical difference between them while three adjacent environments did. Results were mixed; all three opposite environments demonstrated no statistically significant differences. The results of the Question Two analysis produced similar results. The MANOVA of five questions and six environments found some adjacent environments had statistically significant differences while some did not. Also, some opposite environments had statistically significant differences from each other, while others did not. The results of the Question Three analysis also revealed inconsistent results. The cluster analysis suggested that some academic majors, from the same environments, clustered together, while some majors from the same academic environment grouped into different clusters.

Chapter 5 presents the implications of these findings.
CHAPTER 5

INTERPRETATIONS

This chapter discusses the interpretations of the findings for each of the three research questions. Question One interpretations consist of recommendations for alternative configurations for Holland’s model. Question Two interpretations examine broad environmental differences among environments and propose a model for expected environmental outcomes. Question Three interpretations address the grouping of academic majors into clusters that contradict Holland’s (1997) theorized grouping. This chapter ends with a summation of theses interpretations and recommendations for future research.

**Question One Interpretations: Alternative Model Arrangements**

Question One examined the data set for statistical differences among the six Holland (1997) environments. Using those results, the following section reorganizes Holland’s (1997) model to align with the data results in a way that minimizes violations to Holland’s (1997) theory, as measured by expected-to-unexpected findings of adjacent and opposite environments.

Research Question One analysis revealed a 2:7 ratio of expected-to-unexpected findings. This means that seven of the nine comparison findings among adjacent and opposite environments are contradictory to the assumption of consistency. Results are contradictory in that four out of six adjacent environments, theoretically more similar to each other, have statistically significant differences among each other. (Refer to Table 12, Chapter Four). Similarly, all three opposite environments, theoretically the most dissimilar, show no statistically significant difference among each other.
In order to improve on expected-to-unexpected differences, three alternative arrangements to Holland’s model are suggested in the following section. These alternative arrangements are improvements over the original model by significantly increasing the number of environment placements that are congruent with Holland’s (1997) assumption of consistency. The alternative arrangements are driven by the study results, and arranged according to the assumptions of Holland’s model.

**Alternative Arrangement I**

The reconfiguration of the model using environments’ mean scores and p-values to rearrange Holland’s model into a hypothetical model that maximizes the number of expected-to-unexpected findings, optimized to the HTS data results. In this configuration the placement of environments were refined by hand using environments’ mean scores and the p-values among environments. Mean scores were used to arrange the environments in a gradually descending pattern around the Hexagon. P-values were used to further refine the arrangement of environments on the Hexagonal Model by guide placement of environments to maximize expected-to-unexpected findings among adjacent and opposite environments.

Mean scores and p-values were used to position environments in a way that most aligned with Holland’s assumptions. Environments were arranged to minimize mean score differences between adjacent environments and differences of statistical significance among adjacent environments. Environments were also arranged to maximize mean score differences and differences of statistical significance between opposite environments. It is for this reason that environments on the reconfigured model are not necessarily adjacent to the two environments numerically (i.e. mean values)
Figure 2. Holland’s Hexagonal Model, Arranged According to HTS Scalelet Mean Scores.
closest to them, or numerically most distant for opposite environments. Multiple rearrangements of the model were created. Ultimately, the model in Figure 2 maximizes expected-to-unexpected findings, while still preserving Holland’s assumptions of environmental consistency/inconsistency to the extent possible. The environments in Figure 2 are listed with the original numbering assigned to environments for this study, which can be used to compare this new arrangement to that of the original model.

This reordering of environments increases expected-to-unexpected findings to 6:3, compared to the 2:7 ratio of the original placement of environments on the Hexagonal model.

The next figure, Figure 3, lists the p-values between the environments in Figure 2 to identify statistical significance or non-significance between the environments’ mean scores. The three unexpected findings in this model are noted by an asterisk. The three sets of environments that have unexpected statistical differences are the two adjacent environments Social(4)/Enterprising(5) and Investigative(2)/Artistic(3) and the opposite environments of Enterprising(5)/Investigative(2).

The arrangement in Figure 3 identifies the limitations of placing environments on the Hexagonal model according to mean score similarities. If environments are grouped by increasing difference of mean values, to the right and left of any given environment, then some opposite environments, supposedly the most dissimilar, may not have a statistically significant difference between each other. The problem of statistically similar opposite environments happens because of the hexagonal ordering of environments using the assumption of consistency. This problem is demonstrated by the p-value of 0.966.
* Figure 3. Holland’s Hexagonal Model and Corresponding P-Values.

* Indicates unexpected P-Value findings between environments.
between the opposite Enterprising (5) and Investigative (2) environments on the reorder model of Figure 3

Based on group mean score measurements of environmental characteristics, this phenomenon of consistent opposite environments is a potential persistent problem for the Hexagonal Model. This happens because the adjacent environments that are between an inconsistent opposite pairing will theoretically have mean scores that fall between those of the opposite pair. These middling scores create a potential for the mean score of one, or both, of the remaining opposite environments to “meet in the middle,” as it were, and not demonstrate a statistically significant difference.

To avoid this problem, there must be a large mean difference between one set of opposite environments. This allows the other two opposite environment pairs the possibility to have mean scores with a statistically significant difference. This also creates a potential model where adjacent environments have a statistically significant difference among each other. This situation is not necessarily incongruent with the model’s assumption of consistency just as long as mean differences among environments change in a uniform ascending or descending manner around the Hexagon.

In order for Holland’s (1997) model to function as theorized, the mean difference among one set of opposite environments must be large and environmental differences must change in a gradual manner around the Hexagon. This situation allows for both environmental consistency and inconsistency to occur. To maintain environmental consistency, differences among environments must gradually change. To maintain inconsistency, there must be statistically significant differences among opposite environments. The notion of a gradual increase in difference among environments, on a
circular model, appears intuitive as a theoretical framework. However, the Question One statistical analysis reveals deficiencies in the assumptions of consistency/inconsistency of environments on the Hexagonal model that calls for the need for exploration of alternative model arrangements.

**Alternative Arrangement II**

HTS findings suggest opposite environments have more in common with each other than suggested by the environmental descriptions outlined by Holland (1997). A lack of differences among opposite environments invites a reevaluation of broader environmental definitions. As suggested by HTS findings, if there are no practical statistical differences among select environments, logically, the environmental model can be simplified by merging similar environments. Based on Question One data analysis, because of little statistical difference between mean scores of opposite environments’ in Holland’s original configuration, I propose the six environments may be merged into three composite environments. It is interesting to note that these three pairings are each made of opposite environments, environments Holland’s (1997) model predicts to be the most dissimilar. Opposite environments, their mean scores, and p-values between their mean scores are listed in Table 23.

<table>
<thead>
<tr>
<th>Opposite Environment Mergers</th>
<th>Mean Scores</th>
<th>P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Realistic(1) / Social(4)</td>
<td>72.40 / 73.68</td>
<td>0.927</td>
</tr>
<tr>
<td>Investigative(2) / Enterprising(5)</td>
<td>70.61 / 70.14</td>
<td>0.966</td>
</tr>
<tr>
<td>Artistic(3) / Conventional(6)</td>
<td>68.04 / 67.01</td>
<td>0.969</td>
</tr>
</tbody>
</table>
The p-values in Table 23 illustrate the similarity of mean scores between opposite environments. These p-values illustrate the essential non-difference among these groups and are the justification to merge six environments into three homogeneous environments. Figure 4 below shows a theoretical merging of the six academic environments, based on Question One HTS findings.

![Figure 4. Proposed Merging of Academic Environments](image)

These three pairings are merged because of empirical findings of general similarity based on a single measure of HTS mean comparisons. In order to validate these, or other, recommendations to merge environments, configurations may be tested by combining the data of statistically similar environments and then comparing the merged environments among each other. Merged environments may be compared using means and p-values for statistical significance or difference in the same manner used in this research. Environments may be assessed for compatibility based on other discreet factors such as engagement levels, curricular factors, or personality characteristics of constituent students and faculty. Further in-depth analysis and empirical research of
environments may validate these findings or identify other compatible environments to merge.

One problem with this arrangement is the potential for statistically significant differences among two sets of the merged groups. The following section offers a suggestion to eliminate this possibility.

**Alternative Arrangement III, Linear Ordering.**

Another alternative placement of environments may be used to avoid the problems of opposite environments with no statistically significant difference or adjacent groups with statistically significant differences, as outlined in the previous sections. To avoid this problem, environments may simply be ordered by mean scores in a linear rotation around the Hexagon. Hypothetically speaking, if one set of opposite environments have the highest and lowest mean scores, then the adjacent and non-adjacent environments between this pair have the potential to be essentially the same, or have only a slight difference among each other. In order to identify gradual environmental differences, they may be placed in a linear order, descending by mean score. This will allow for identification of gradations among environments without arbitrarily separating groups on a theoretical model, or reconfiguring the model manually, as in Alternative Arrangement I.

To create a linear model, environments may be ordered clockwise or counter clockwise. A clockwise rotation is used for this adjusted model. A circular arrangement of environments is what Holland’s model assumes. This means there are gradual environmental difference among adjacent environments, (i.e., environments on both sides of any given environment are gradually different.) An example of linear ordering is
outlined in Figure 5. The environment with the highest mean score, Social (4), is placed on the top left position. Environments are then placed linearly from the Social (4) environment in a clockwise, descending order by mean scores.

It is within this configuration that expected-to-unexpected findings are maximized to a ratio of 8:1. This ratio far exceeds the expected-to-unexpected ratio of 2:7 of the original model, and 6:3 of the reconfigured model in Figure 3. In this linear reconfiguration, environments are placed in a descending order. The environment with the highest mean score is placed first and environments are then positioned according to mean scores, in descending numerical order. When this was done with the HTS findings of this research, a semi-circular linear model is produced that fits almost perfectly with the assumptions of consistency/inconsistency for adjacent and opposite environments. The only unexpected finding was between the first to be placed environment, Social (4), and the last to be placed environment, Conventional (6). In this reconfigured model, this one adjacent pairing has a statistically significant difference, incongruent with Holland’s assumption of consistency. The p-value between their group means is 0.000. This is the only pairing in this alternative model that demonstrates a statistical relationship incongruent with Holland’s assumptions. The three opposite environment pairings, on this updated model, all have a statistically significant difference among each other. All of the other adjacent and opposite environments have statistical similarities or differences congruent with model assumptions.

Given the 8:1 expected-to-unexpected ratio of Figure 4, Holland’s environments are more congruent with his assumptions when placed on a linear, semi-semicircular
Figure 5. Holland’s (1997) Hexagonal Model, Arranged According to HTS Scalelet Mean Scores. * Indicates unexpected P-Value findings between environments.
spectrum than when positioned on a circular hexagonal model. The limitation in this ordering is that it then leaves the last adjacent pairing with a potential for a statistically significant difference. However, by disregarding one assumption in one instance, a higher ratio of expected-to-unexpected environments was achieved then when environments were ordered according to Holland’s original model.

**Section Conclusion**

Question One findings are mixed. In one sense Holland’s (1997) model is upheld. Some environments have the expected, and some unexpected, statistically significant differences among each other. However, to a greater degree, the original model is found lacking statistically when viewed vis-à-vis HTS scores. Findings contradictory to Holland’s assumptions are found in environments’ p-values and mean scores. In the original model, four adjacent environments have a statistically significant difference among each other, using the HTS measure. None of the opposite environments have any statistically significant difference among each other. Not until the recalibrated configuration in Figure 4 are expected-to-unexpected findings generally congruent with the model’s assumption of environmental consistency. The Figure 4 recalibration produced only one incongruent adjacent environmental pairing, a significant improvement over the original model results.

These findings exemplify the need for further empirical analysis of Holland (1997) academic environments and a reevaluation of the Hexagonal model’s assumption of environmental consistency/inconsistency. These findings show the need to determine if the placement of environments on the Hexagonal model is in accordance to the assumption of consistency and inconsistency. The theoretical notion of gradually
increasing differences among environments on the Hexagonal model is intuitive and logical but it is the placement of environments on the model that this research calls into question. These findings draw some doubt to the veracity of Holland’s placement of environments on the Hexagonal model, according to this measure of higher-order thinking skills. In fact, a placement of the environments, to maximize the model’s assumptions, may well depend on the measure across which the environments are compared. Implications of these findings are outlined in the Discussion section.

**Question Two Interpretations: Environmental Differences**

Question Two examines the data to identify environmental engagement demand differences theorized by Holland. This analysis revealed that there are differences among environments, though at times not necessarily as theorized. Question Two analysis takes a different approach to examine the data than that used in Question One. Results from Question One were used to rearrange the model according to HTS scalelet findings, because this scalelet is a broad assessment of environmental demands on students. In contrast, the five individual questions of Question Two represent measurements that are too discrete by which to suggest rearranging a multifaceted and complex environmental model. Hypothetical Hexagonal models will not be suggested for Question Two findings because of these analytical differences. Rather, the results from Question Two are used to order the six environments, according to mean scores, for each of the five questions, in a manner similar to the linear ordering recommended in the previous section. Environments are ordered like this to identify basic differences among the six environments and to gain insight into unique aspects of environmental demands on students. As with Question One, Question Two analysis also examines expected-to-unexpected ratios of environmental
consistency. From these findings a model is created that orders expected outcomes of environments’ scores on quantified measurements. This Question Two analysis section concludes with a list of implications of these findings.

**Ranked Environments by Means**

In order to identify general differences among environments, the following section examines a ranked ordering of environments, by mean scores, for each of the five HTS questions. Environments are ranked to identify any patterns that may exist within the data results. The following findings offer support for the assumption of environmental differences. Table 24 is a list of all environments and their ranked order by mean scores, for each of the five questions that comprise the HTS Scalelet. The number preceding the environment is the number assigned to them for research purposes. Environments’ mean scores are listed in Table 20, Chapter Four.

Table 24 lists the environments according to the five HTS questions. In each of the rows the environments are listed under an individual question. The environment with the highest mean score is listed on top of the list, with environments listed under it in descending order. Notice in Table 24 the environments that consistently score within the top half of each of the five questions. The Investigative and Social environments rank within the top three environments, for four of five questions. The Enterprising environment is within the top three environments, for three of five questions.

The data analysis reveals that the Investigative, Enterprising, and Social environments require students to process information to a high degree on multiple HTS dimensions. These results signal an environmental requirement for a breadth of processing capabilities from students within these environments. Holland (1997)
identifies specific characteristics of each environment that may lead to an explanation of these Higher-order Thinking Skills scores. Populations within the Investigative environment enjoy analytical activities that are often inquiry based. Enterprising environments are made up of people motivated by financial gain or attaining organizational goals. People within Social environments enjoy helping and teaching. A commonality among these three environments may be the number of variables that must be processed in order to carry out the functions needed in each of the environments.

This knowledge of environmental HTS demands is potentially useful to individuals looking for an academic environment to join. Students interested in being engaged on multiple higher-order thinking skills may consider enrolling in majors within one of these three high HTS demand environments. Students who want this particular challenge will fit in more with other students who have similar engagement interests and appreciate the multiple demands placed upon them by the faculty. These environmental demands stand in contrast to the limited, or focused, demands of the three low HTS scoring environments.

Notice also in Table 24 the environments that consistently score within the bottom half of each of the five questions. The Artistic and Conventional environments are within the bottom three environments, for four of five questions. The Realistic environment is within the bottom half of environments for three of five questions.

One possible explanation for these results is that the nature of the content studied has lower demands across multiple higher-order thinking skills, possibly because these fields require less processing demands of multiple variables associated with the course content. These results signal that these environments have focused demands on students,
Table 24

*Environments’ Responses, in Descending Mean Order by HTS Question*

<table>
<thead>
<tr>
<th>Question</th>
<th>Memorizing</th>
<th>Analyzing</th>
<th>Synthesizing</th>
<th>Making Judgments</th>
<th>Applying</th>
</tr>
</thead>
<tbody>
<tr>
<td>2: Investigative</td>
<td>1: Realistic</td>
<td>4: Social</td>
<td>4: Social</td>
<td>1: Realistic</td>
<td></td>
</tr>
<tr>
<td>5: Enterprising</td>
<td>4: Social</td>
<td>3: Artistic</td>
<td>5: Enterprising</td>
<td>4: Social</td>
<td></td>
</tr>
<tr>
<td>1: Realistic</td>
<td>3: Artistic</td>
<td>1: Realistic</td>
<td>3: Artistic</td>
<td>5: Enterprising</td>
<td></td>
</tr>
</tbody>
</table>
demands which require knowledge and processing of specific, detailed, information. According to Holland (1997) the Artistic environment focuses on being emotionally expressive. This may draw students and faculty who are more attuned to emotional feelings and less introspective, in a way that does not require a high level of higher-order thinking skills. The Conventional environment centers on explicit, ordered jobs and the Realistic environment is defined by concrete, practical activities. Both environments contain a category of jobs which, arguably, do not require multiple higher-order thinking skills to carry out, but do require a depth of specific, focused knowledge.

An examination of HTS questions that have high scores for these three environments reveals that these environments require students to process information in a way that positively facilitates processing of environmentally specific content knowledge. The Artistic environment has high demands for Synthesizing information. This is logical for this environment because of the need to combine multiple mediums of communication to expression ideas. The Conventional environment has a high demand for Memorization of information. This makes sense considering the focus of occupations within this environment that require performance of explicit, ordered jobs. The Realistic environment has high HTS demands for Analyzing and Applying information. Given the nature of the concrete, practical jobs within this environment, it makes sense that analyzing a problem and applying known processes to come up with a solution are in high demand of students within this field. These environments with “low” HTS mean scores should not be considered as inferior to the three high HTS demand environments. Each environment has a unique occupational demand that it serves, and each one requires unique interests, behavior, and skills of its students.
Expected-to-Unexpected Findings

Question Two findings again demonstrate that environmental engagement demands do differ by a statistically significant margin. However, the interesting material is the analysis of how environments differ among each other in ways not assumed by Holland’s (1997) model. To show these differences, a transition is made from the general high/low comparisons of the previous section, to a more precise analysis of expected-to-unexpected findings among adjacent and opposite environments. Expected-to-unexpected findings among environments illustrate that environments do differ, as theorized by Holland, but not in ways predicted by the model. For Question Two, all 30 possible combinations of adjacent environment were analyzed. (There are 30 comparisons because there are six unique adjacent environments combinations per five HTS question, given five questions.) The analyses of the five HTS questions revealed a 13:17 ratio of expected-to-unexpected findings for adjacent environments. These findings offer limited support for the validity of the model, using the HTS measure. Thirteen of the thirty adjacent environment comparisons demonstrate similarities predicted in the assumption of consistency, with most of the adjacent environment pairings incongruent with the model’s assumption.

In contrast to these findings among adjacent environments, opposite environments demonstrate a general alignment with model predictions. There are 15 opposite environment pairings analyzed in this study. (There are 15 comparisons because there are three opposite environment pairings, per HTS question, given five questions.) Opposite environments for Question Two have a 9:6 ratio of expected-to-unexpected findings. (Refer to Table 18, Chapter Four). Nine out of fifteen opposite environment comparisons
demonstrate expected statistical differences. This ratio is generally congruous with the model’s predictions of inconsistency, and offers general support of the model of environmental differences and the ordering of these environments on the Hexagonal model.

A closer analysis of these findings reveals that environments differ in ways not theorized by Holland (1997). The environmental differences identified in Question Two analysis highlights the discrepancy between Holland theorized environmental consistency and the actual findings of environmental consistency. It is an interesting note that, in the analysis of Question Two, the statistical differences among adjacent environments are generally incongruent with the assumption of consistency, while opposite environment findings are generally congruent with model assumptions. In Question One the reverse is true: findings among adjacent environments offer some support for theorized environmental differences, and opposite environment findings offers no support. This difference of statistical findings between Question One and Question Two may be explained by the inclusion of the Memorization question in Question Two, or it may be explained by an individual HTS question’s mean scores that skews the Question One HTS composite mean scores to a high or low mean average.

A Theoretical Model for Expected Environmental Ordering Outcomes

Based on Holland’s (1997) assumptions of environmental consistency/inconsistency a model of expected environmental ordering emerges that can be applied to any hypothetical situation. I considered the order of environments using expected-to-unexpected ratios for Questions One and Two. According to the ranking of environments by HTS mean scores and the assumption of consistency/inconsistency, I
saw how environment scores actually came out compared to how they should have come out if Holland’s assumptions held true. Using Holland’s (1997) assumptions of consistency, and taking the next step of implementing a linear ordering of mean scores, an explanatory model of environment mean scores emerged. The explanatory model assumes the validity of Holland’s arrangements of environments on the hexagon and consistency among environments.

Based on this research analysis, this explanatory model has five propositions. The first proposition is that one set of opposite environments (environments 1 and 4, 2 and 5, or 3 and 6) will have the highest and lowest mean scores among all six environments. It does not matter which two environments are the highest and lowest scoring, just as long as they are opposite environments. Nor does it matter which environment of the pair has the highest or lowest score. The second and third propositions are that the environments with the second and third highest scores will belong to environments adjacent to the highest scoring environment. The fourth and fifth propositions are that the two environments with the fourth and fifth highest scores will belong to environments adjacent to the lowest scoring environment.

For this explanatory model, Table 25 lists the expected order of environmental scores, for a hypothetical group of mean scores. In order for environment mean scores to be congruent with the model’s assumptions of consistency/inconsistency the highest scoring and the lowest scoring environments would be opposite environments. The middling four environments should then be ordered according to adjacent then non-adjacent environments. This method may be used for any given assessment with any quantifiable measure, for which one wishes to construct a configuration based on
Holland’s assumptions.

Table 25

*Expected Environmental Ordering, for a Hypothetical Question*

<table>
<thead>
<tr>
<th>Environment</th>
<th>Environment Hexagon Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>4: Social</td>
<td>Opposite Environment to 1</td>
</tr>
<tr>
<td>5: Enterprising</td>
<td>Adjacent to 4, non-adjacent to 1</td>
</tr>
<tr>
<td>3: Artistic</td>
<td>Adjacent to 4, non-adjacent to 1</td>
</tr>
<tr>
<td>2: Investigative</td>
<td>Non-adjacent to 4, adjacent to 1</td>
</tr>
<tr>
<td>6: Conventional</td>
<td>Non-adjacent to 4, adjacent to 1</td>
</tr>
<tr>
<td>1: Realistic</td>
<td>Opposite Environment to 4</td>
</tr>
</tbody>
</table>

In the Table 25 example, Environment 4 has the highest mean score and Environment 1, its opposite environment, has the lowest mean score. The next two environments, with the 2\textsuperscript{nd} and 3\textsuperscript{rd} highest mean scores, would be environments 5 and 3. The 4\textsuperscript{th} and 5\textsuperscript{th} highest environments will be environments 2 and 6, as environments 2 and 6 are adjacent to Environment 1, the lowest scoring environment. This explanatory model is very similar in concept to the linear placement of environments recommended in Figure 4. Both models order environments according to assessment scores, in descending order by mean scores, and maximize expected-to-unexpected findings among environments. To demonstrate these proposition rules, I will analyze the data from Question Two, through the lens of these rules, to identify the expected-to-unexpected ratio for each of the five HTS questions.

The following paragraphs show how the Making Judgments question is the question that comes closest to the expected outcomes for Holland’s model but still lacks a total adherence to expected outcomes. This one question meets 3 of 5 expectations, and violates 2 of 5 assumptions. Question Two analysis shows only one question where environmental ordering is close to Holland’s expected model, the Making Judgments
question (Refer back to Table 24). For this example the opposite environments 4 and 1 are the highest and lowest scoring environments, the middling adjacent and non-adjacent environments are not ordered as expected. The environments with the 2nd and 3rd highest mean scores should be Environment 3 and 5, but instead Environments 5 and 2 are adjacent to 4; one environment is adjacent and one is non-adjacent to Environment 4. The 4th and 5th highest mean scores, theoretically should belong to environments 2 and 6, but instead belong to Environments 3 and 6. Just like the 2nd and 3rd environments in this ordering, these two environments are also a mix of two environments, which are adjacent and non-adjacent to the lowest scoring environment, Environment 1. Table 26 summarizes the expected-to-unexpected ratio for all five individual HTS questions.

Table 26
Research Question Two Summary of Environmental Ordering

<table>
<thead>
<tr>
<th>Measure</th>
<th>Expected: Unexpected Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Memorizing</td>
<td>1:4</td>
</tr>
<tr>
<td>Analyzing</td>
<td>0:5</td>
</tr>
<tr>
<td>Synthesizing</td>
<td>2:3</td>
</tr>
<tr>
<td>Making Judgments</td>
<td>3:2</td>
</tr>
<tr>
<td>Applying</td>
<td>1:4</td>
</tr>
</tbody>
</table>

The Making Judgments question has the highest expected-to-unexpected ratio of 3:2, while the Analyzing question has the lowest ratio of 0:5. Through highlighting the inconsistency of theoretically similar environments and the consistency of theoretically dissimilar environments, these expected-to-unexpected findings identify a weakness in Holland’s placement of environments on the Hexagonal model.

Implications
Question Two results show that Holland’s (1997) assumption of environmental differences holds true; some of the environments consistently score high on measurements of higher-order thinking skills while others consistently score low. The literature offers similar results on environmental differences. Some studies identify distinct disciplinary differences (Nelson Laird et al., 2008) and different learning outcomes among environments (Bohr, 1991; Whitmere, 2002; Smart, 2008), while other studies identify few, if any, disciplinary differences (Hativa & Birenbaum, 2000; Li, Long, & Simpson, 1999; Cashin & Downey, 1995). This research has shown that demonstrable differences do exist among different academic environments. However, in many instances, environments differ in ways not assumed by the model. Findings that confirm Holland’s (1997) assumptions are the adjacent environments that are statistically similar to each other (or consistent), and opposite environments that are statistically dissimilar to each other (or inconsistent). Conversely, findings that bring doubt to the reliability of the model are adjacent environments that are statistically dissimilar to each other and opposite environments with no statistical differences.

Findings from Question Two, combined with the findings from Questions One, lead me to conclude Holland’s (1997) model is based on a valid assumption by which to organize and compare academic environments, but it is in need of attunement to a changing academic landscape. Attunement of the model may take one of the two forms. The first option is that the Hexagonal model is preserved but environments are reconfigured, such as the reconfigured model in Figure 2, Chapter 5. The second option is to reconfigure the model into a linear model, as outlined in the previous section.
There is one caveat to this recommendation: The academic majors chosen to comprise these environments influence the results of environmental mean scores and the interaction among environments on the Hexagonal model. These scores are the result of the unique makeup of majors chosen for this study. Follow-up studies of environmental similarities and differences should add additional majors to the environments for a broader view of environmental characteristics. Further reordering, or consolidation, of Holland’s environments will best be predicated on an evaluative analysis followed by a regrouping of majors into environments. This recommendation is based on the Question Three findings covered in the next section. Question Three findings reveal mixed results concerning the homogeneity of majors within the same environment.

Finally, the HTS questions are students’ assessments of environmental demands, (i.e. faculty demands on students). The study’s results call for further analysis of faculty and curricular differences of engagement demands on students, and thus the different influences environments have on students. Once differences are identified, faculty within environments or majors may adjust engagement demands on students, or faculty interactions with students, to improve student learning and positive outcomes (Ullah & Wilson, 2007; Kuh & Gonyea, 2005; Kuh et al., 2007). Regardless of the measure used to assess environmental conditions, differences among environments should conform to the theoretical model outlined in Table 25.

Section Conclusion

These findings offer a glimpse into one way to evaluate specific differences among academic environments, and demonstrate one way which Holland’s (1997) theoretical assumptions of consistency/inconsistency can be quantified. In the course of
this study, this research identified specific differences among environments, as theorized by Holland (1997). This research suggests that measurements may be used to identify differences among environments, that there are empirical ways to measure environmental engagement differences, and there are assessment techniques which can be used to investigate the validity of this model of academic environments. This research supports Holland’s (1997) model as far as there are statistically significant differences among environments.

### Question Three Interpretations: Placement of Academic Majors

The Question Three cluster analysis results bring into question the methods used by Rosen, Holmberg, and Holland (1997) to place majors into environments. For the population studied, the cluster analysis results reveal a disjointed pattern of theoretically consistent and inconsistent majors grouped into the same clusters. (Refer to Tables 21 and 22). Results show half of the majors from the same environments are grouped together into the same clusters, while half of the majors from the same environments are grouped into separate clusters. In clusters 1, 2, 3, and 4 some majors from the same and/or consistent environments are grouped together into the same clusters. For example, the Investigative (2) environment saw half of its majors clustered together. The same results happened for the Artistic (3) and Enterprising (5) environments. Results incongruous with model assumptions are the majors from inconsistent environments which are clustered together. Also incongruent with the model assumptions is that half of the majors from the same and/or consistent environments that are separated from each other and placed into different clusters. One interesting finding, and wholly incongruent to the assumption of consistency of majors within the same environment, is that the five
compositional majors of the Social (4) environment were divided among five clusters. Question Three findings are consistent with findings from Research Questions One and Two, in that analysis results point to a potential need to update Holland’s model.

Implications

Findings from Question Three analysis lead me to believe a reevaluation of the placement of majors into environments is needed. Cluster grouping results bring into question the current categorization method Rosen et al. (1997) used in The Educational Opportunities Finder to place majors into environments. The cluster analysis results are a dizzying array of matches among consistent and inconsistent majors. These results tell me that theoretically similar majors are statistically dissimilar, and theoretically dissimilar majors are similar. These findings may be attributed to the placement of majors into environments in the 1990s, when the majors were placed into environments. The research findings, of unexpected differences among academic majors, may be attributed to the changes among faculty and/or student populations that comprised academic majors in the 1990s. The academic majors and environments of the mid 1990s may have had characteristics different from the population that inhabited academic majors in 2005, the year of the data sample. Research findings which are incongruent with Holland’s (1997) assumption may be explained by changes within majors that happened because of evolving course content or shifts in the makeup of the student/faculty population. Over the course of a decade, characteristics of faculty within academic majors and environments may have changed. If this change took place, then the demands on students may have also changed and majors within environments were no longer uniformly similar. This shift among majors may have then altered the consistency and inconsistency
interactions among environments away from those ways predicted by Holland’s model. This is, of course, assuming that majors were correctly placed within environments in the first place.

These results direct me to the recommendation that majors be reassessed for categorization within academic environments. Modifications to the grouping of majors into environments are needed to accurately place similar academic majors into environments. Further analysis of majors’ placement into environments is called for in order to definitively determine the best way to group majors into environments. Recommendations to carry out a reevaluation of majors within environments, among other recommendations, follow in the next section.

**Summary: Recommendations for Future Research**

This study demonstrates that there are engagement differences among academic environments. These findings call for more research to be conducted on academic environments’ engagement demands on students and how these differences influence student learning, or other outcomes. However, the findings that offer the most fodder for this research are that engagement differences among academic environments manifested themselves in ways not theorized by Holland’s (1997) model. Synthesized as a whole, the findings, implications, and recommendations from Questions One, Two, and Three lead me to make the broad recommendation that the placement of environments on the model should be reevaluated and reordered, characteristics of academic majors and environments reassessed, and assignment of majors into environments reevaluated.

Question One findings revealed a weakness in the placement of environments on the circular Hexagonal model. Results showed that environments do differ, but not in
ways theorized by Holland (1997). My analysis revealed that opposite environments had no statistical difference within the three sets, but adjacent environments did have statistically significant differences. From these findings, I recommend that one or more of the following actions take place: reorder the placement of environments on the Hexagonal model; combine environments when there is no difference among them; or shift the model to a linear order of environments, instead of the current circular arrangement. I reiterate the note that environmental ordering outcomes will depend on the assessment measurement.

Question Two findings also reveal that there are differences among environments, but the differences are at times not consistent with Holland’s (1997) assumptions for the Hexagonal model. Analysis showed that environments do differ, as verified by some environments with generally high HTS scores and some with generally low scores. Expected-to-unexpected findings reveal that environments differ, though in ways not theorized by Holland. From these findings, I created a model that identifies how environmental measurement scores may fall, in accordance with Holland’s assumption of consistency. When these findings are viewed through my model, based on the assumption of consistency, a weakness in the placement of environments on the Hexagonal model emerges. I recommend a reassessment of the characteristics of academic majors and academic environments, and a reevaluation of the placement of academic majors within environments.

Question Three findings revealed that majors within the same environment are not uniformly similar in terms of higher-order thinking skills. There is a need for a reevaluation of a broader range of majors within academic environments, for the purpose
of regrouping majors into homogeneous environments. To do this regrouping, I recommend using the HTS scalelet because it measures a very important factor within education: cognitive demand on students.

This study raises a number of questions concerning the actual differences among Holland (1997) defined environments and the ability of the current classification of academic majors to categorize them into homogeneous academic environments. Results from Questions One, Two, and Three lead me to the conclusion that either Holland’s classification of academic majors was wrong to begin with, or HTS characteristics of the populations within academic majors and environments shifted over the course of a decade. To improve upon Holland’s (1997) model, I offer a recommendation to recalibrate it to reflect the characteristics of today’s academic majors and environments. The first step to recalibrate the model is to reevaluate the placement of academic majors into environments. Academic majors were originally placed into environments based on Holland’s sorting of occupations into environments, or placements were based on theoretical notions of environmental characteristics (Rosen et al., 1997). Majors were not categorized into environments based on actual measurements of academic environment characteristics. To make up for this lack of accurate classification, the totality of majors found in the Educational Opportunities Finder (Rosen et al., 1997) should be reassessed for an updated placement within environments.

The environments used in this study were composed of a narrow field of majors. Academic majors not chosen for this research should be included in future environmental assessments, as a different composition of majors within environments may produce different findings. Once a breath of majors are categorized and regrouped into
homogenous environments, then the placement of environments on the Hexagonal model should be reviewed so environments group according to the model’s assumption of consistency. The HTS scalelet is an important measure by which to categorize majors into environments and situate environments among each other, because it examines demands on students’ thought processes. HTS demands on students arguably shape how students think, and shaping students’ thought processes is the main goal of higher education.

This research examined a specific aspect of engagement differences among environments. The study of academic environments will benefit from a thorough examination of these engagement differences among academic majors and environments. The HTS NSSE questions are ideally suited to categorize majors into environments, and guide the placement of environments on the Hexagonal model. However, relying on dataset scores, as this study does, may not offer sufficiently exhaustive HTS climatic evaluations for a thorough assessment. Qualitative studies of the HTS levels of students and faculty who populate a given major or environment may also be used to identify these characteristics.

Lastly, I second a call by Smart (2008, p. 19-20) to merge multiple environmental classification systems into a categorization tool better suited for today’s academic majors and environments. I see the strength of combining other typing systems with Holland’s environmental theory. Taxonomies that may be combined with Holland’s include Biglan’s (1973a, 1973b) taxonomy of the nature of majors’ curriculum or Kolb’s (1981) taxonomy of learning style differences. If these models are merged together with Holland’s into one theory, then environments can be resituated among each other on a
Hexagonal model. Alternatively, classification systems may be kept separate, but used in conjunction to find a suitable match for a student. In this scenario the same majors will each be assessed according to HTS scores and curricular factors. Students will take assessment tests, with matches made according to multiple unique assessments. This process will apply for students to focus on particular academic environments or majors.

Summary

This chapter discussed the research findings, including the main findings that Holland’s theory of academic environments has merit. However, the model will benefit from a review of the situation of environments among each other on the Hexagonal model and the grouping of academic majors into environments. This study is an important first step in the reexamination of Holland’s model and grouping of majors into environments. This study contributed to the literature by examining engagement levels among academic environments and reviewing a categorization model of environments utilized in current research. Due to the limited number of majors used to comprise the academic environments, further research is required to validate these findings. Research of engagement differences among academic majors and environments should continue, as should the development of a refined categorization system of majors into academic environments, and the situation of academic environments on Holland’s model. To this end, I offered a few recommendations for future research.
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